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The Engineer

Vol. CLXXVI—No. 4578 28, ESSEX ST., STRAND, LONDON, W.C.2 OCTOBER 8, 1943

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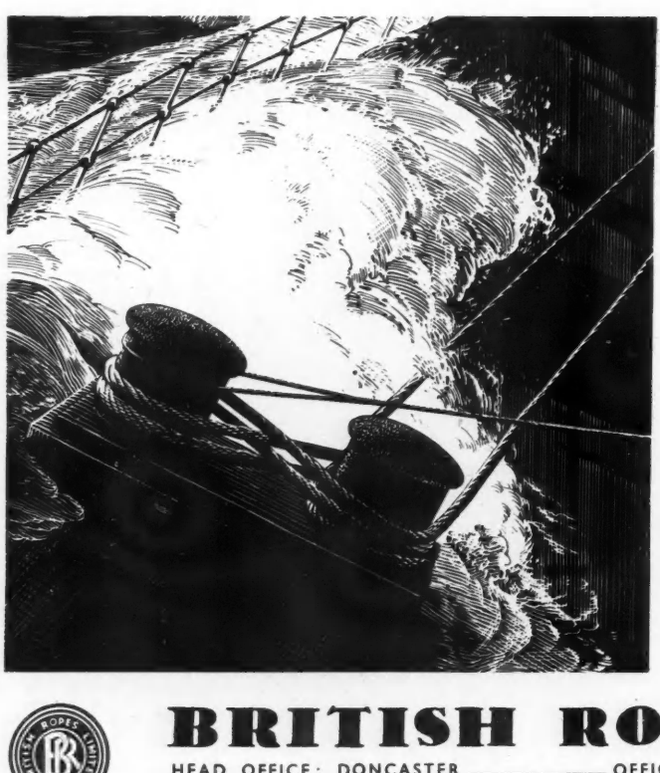

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ed and endorsed Tenders to be received by ndersigned not later than Monday, ber 15th.

E. B. WISE,
Borough Engineer and Surveyor.

n Hall,
Christchurch,
1st October, 1943. 8393

EXFORD COUNTY COUNCIL

MPETITION FOR DESIGN OF BRIDGE

NOTICE TO CIVIL ENGINEERS

e Wexford County Council

invite Civil Engineers to take part COMPETITION for the DESIGN of a D BRIDGE over the estuary of the River at Wexford. The clear width of the way is approximately 1020ft. The bridge be in reinforced concrete.

pendent assessors have been appointed, their final award will be accepted by the il.

ditions of the Competition, including the of the Assessors and amounts of pre-, instructions to competitors, details of ure, schedule and form of entry, may be rom the undersigned.

N. J. FRIZELLE,
County Secretary.

nty Hall,
Wexford,
September, 1943. 8375

NORTH OF SCOTLAND HYDRO-ELECTRIC BOARD

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plications are Invited by

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he Council Invites Appli-

CATIONS for the POST of PROFESSOR NGINEERING. Minimum salary £1000 per m. It is hoped that suitably qualified ons engaged in national service will apply. rther particulars may be obtained from the rsigned, by whom applications must be ved on or before November 20th, 1943.

EDWIN DREW,
Registrar.

ngleton Park, Swansea. 8331

ADVERTISERS UNDER BOX NUMBERS IN SITUATIONS OPEN SECTION.

r the benefit of applicants, the Proprietors repared to insert brief notices that vacancies filled, upon receipt of notifications from the rtisers. These notices (limited to one line) be free of charge, and co-operation is d for.

The Engineer

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SITUATIONS OPEN

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SITUATIONS OPEN

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The Engineer

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Letters relating to the Advertisement and the Publishing Departments of the Paper are to be addressed to the Publisher; all other letters are to be addressed to the Editor of THE ENGINEER.

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Teleg. Address,
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Tel., Central 6565 (10 lines).

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For continuation of Small Advertisements see page 4

A Seven-Day Journal

The Barrow Dispute

In order that there should be no doubt with regard to the position of workers who were at that time still on strike at Vickers-Armstrongs, Barrow, Mr. Ernest Bevin, Minister of Labour and National Service, explained, on Friday, October 1st, that at the end of August notice was given to his Department by local representatives of a dispute regarding the interpretation of an award of the National Arbitration Tribunal in its application to certain workers in Barrow. Awards of the National Arbitration Tribunal were legal and binding and the question raised was whether or not the award was being properly applied. The Ministry of Labour immediately brought the matter to the notice of the executives of the unions concerned and of the Engineering and Allied Employers' Federation. They confirmed that certain general questions of interpretation of the award, including the particular issue arising at Barrow, were about to be discussed. In accordance with the requirements of the Arbitration Order, the dispute was formally referred by the Minister within twenty-one days to the machinery of the industry for settling disputes. In addition, the Minister asked for reports of the progress made by the machinery of the industry and the steps taken to dispose of the matter, and the executives of the unions and the Employers' Federation were told that if there was failure to reach a settlement or undue delay the Minister would have to refer the dispute to the National Arbitration Tribunal. The unions were asked to inform their members of the action taken by the Minister. There was a meeting of the two sides of the industry on September 17th, when they agreed to ask the Arbitration Tribunal for an interpretation of the award. The Tribunal met at the earliest possible moment and communicated its decision within twenty-four hours. The trade union officials took immediate steps to convey the decision to their members and again instructed them to return to work. The Government was determined to support constitutional methods of settlement of industrial questions and the success of those methods was dependant upon the maintenance of the authority of the trade unions. The matter which was in dispute had now been settled beyond doubt and the decision of the Tribunal was final and binding. The workers who were on strike were deliberately flouting their own agreements and the arbitration procedure to which, through their union, they were parties. They were by their acts impeding the war effort and endangering the lives of British fighting men. The only honourable and proper course for the Barrow workpeople was to accept the decision of the Tribunal and end this matter.

The Barrow Strike Settled

The strike which lasted eighteen days and involved about 9000 engineers and allied workers, was settled on Monday afternoon at a meeting of the men, and work was resumed on Tuesday morning. Some 6000 workers attended the meeting and only thirty voted against the recommendation to resume work. It was announced that Vickers-Armstrongs, Ltd., had given an undertaking to apply the award and the Tribunal's interpretations in a full and liberal manner and had promised that where there was any doubt the worker would get the benefit of it. The firm also promised to abolish the premium bonus system and substitute for it a time-piece system. Under the terms that have been agreed upon, the basic rate is now 66s. and the old rate of 46s. is done away with. The firm has also agreed that for the period of the war two representatives of the workpeople will be appointed, whose duty it will be to examine cards in debt, with a view to finding a reason for it. The representatives, who will collaborate with two representatives of the firm, will be paid on the basis of their average earnings while so engaged. It has been further agreed to reduce the times by 10 per cent., which means that the 50 per cent. men receive for a 47-hour week an increase of 3s. 4½d., while the 100 per cent. men will receive a 9s. 9d. increase on the 47-hour week. By transferring to a time-piece system the 50 per cent. men will receive an additional 6s. 4d. for a 47-hour week, which means an increase of 9s. 7d. over the old rate, while the 100 per cent. men will receive an additional increase of 27s., which will amount to a total increase over the old rate of 33s. The official view expressed by the men's trade unions is that the workers have gained 100 per cent. of all they came out for. It is also conceded that the wages adjustments are of such a nature that they apply alike to the lower-rated men and also to those obtaining the higher percentages.

The Society of British Aircraft Constructors, Ltd.

On Friday, October 1st, it was announced by the Society of British Aircraft Constructors, the representative body of the British aircraft industry, that Major H. R. Kilner has been elected President of the Society in succession to Mr. A. F. Sidgreaves, who had been its President since November, 1941. Major Kilner is director-in-charge of the aircraft section of Vickers-Armstrongs, Ltd. He was commissioned into the Royal Field Artillery in 1911 and served on the French and Belgian fronts from 1914–18. Subsequently he held a number of staff appointments. In 1930 he retired from the Army to join the staff of Vickers-Armstrongs, Ltd., and the following year he was appointed general manager of the southern group of factories. He became a director of the company in 1936, and in 1940 he was transferred to the aircraft section, of which he has been director-in-charge since July, 1941. Major Kilner is also a director of Cooke, Troughton and Simms, Ltd. Mr. Sidgreaves, the retiring President, who is managing director of Rolls-Royce, Ltd., becomes Deputy President. Mr. H. Burroughes, a director of the Gloster Aircraft Company, Ltd., has been elected Vice-President.

Railways and Fuel Economy

Addressing a Railway Fuel Economy Conference on September 29th, Mr. M. G. Bennett reviewed the efforts made by British railways to save fuel. Few of the items he mentioned were due to technical improvements, or advances but to simple curtailment of services, as in the warming of trains and waiting rooms, the employment of lower-grade fuels, and the cut in the number and weight of trains. By the last-named method the Southern Railway has effected a saving of 17 per cent., equivalent to 50,000 tons of coal a year. In the case of railway workshops economy has been effected in the same manner as in other works—that is, by the removal of small causes of waste and by economies similar to those effected in our homes. Railway hotels saved 5000 tons last year by reducing heating, cutting out decorative lighting, and so on, and supplies of coal to stations, offices, &c., were reduced by 13,000 tons. Mr. Bennett concluded by stressing the importance of individual effort in the reduction of waste, and mentioned that there is a body of some 15,000 fuel watchers to keep an eye on petty losses, but they are not concerned with railways alone. He mentioned also the "many fruitful discussions" of the Joint Railway Fuel Economy Committee.

Low Temperature Carbonisation, Ltd.

Speaking at the annual general meeting of Low Temperature Carbonisation, Ltd., in London on Friday last, Colonel Whiston A. Bristow, the chairman of the company, said that an increased profit had been earned owing to more coal being made available by the Ministry of Fuel and Power, and that the value of the liquid products had been further enhanced as a result of research. The company had grounds for satisfaction, having already demonstrated what great benefits could be derived from the conversion of bituminous coal into many valuable products instead of burning it and allowing much of its value to be disseminated over our towns and countryside in the form of poisonous smoke. The company, Colonel Bristow said, had been for some time past engaged in making essential war materials for the plastics industry, and was supplying some of the leading firms. The products were first class and steps were being taken to expand that part of the business. There was no doubt that coal derivatives were going to play a leading part in the plastics and rubber industries of the future. In the few years of experiment and development the company had succeeded in establishing for the first time the low-temperature carbonisation of coal upon a satisfactory technical and commercial basis. The possibilities of research had not been exhausted, and there was reason to believe that the work now going on would lead to a still further improvement in the revenues of the company. Unless the whole fuel and power programmes of the country after this war were planned wisely, in conjunction with far-seeing experts of considerable experience and common sense, the country would be deprived of much of the benefit of what had been achieved in the past few years. The first practical mechanical vehicle was put on the road in England in 1802, but it was not until nearly a century later, in 1896, that the Enabling Bill was passed and the way opened for mechanical road transport and the foundations laid of the great motor industry of to-day. Colonel Bristow expressed the hope that similar delays would not prejudice the future fuel and power policy of this country, and that the respective interests of coal, coal conversion, gas, electricity, home-produced coal oils, and petroleum products would be co-ordinated in an equitable and efficient manner for the service of the country and the betterment of all those employed in the coal and allied industries.

Australian Aeronautical Research

In the sixteenth annual report of the Council for Scientific and Industrial Research of the Commonwealth of Australia, for the year ended June 30th, 1942, a copy of which has just come to hand, reference is made to the progress in aerodynamical and aero-engine research. The wind tunnel, with its 9ft. by 7ft. working section and a maximum speed of 300ft. per second, has now been completed. It was designed by the Division staff and the motor and fan were made in England, the instrumental equipment being supplied by a Melbourne firm. Since calibration, the tunnel has been continuously engaged on tests of immediate importance for the aircraft industry. Local problems have been dealt with and a wider programme of research work is in hand. With regard to engines, it is stated that if the rotary valve can be applied to the internal combustion engine it will give an increased ratio of power to fuel consumption. So far, mechanical troubles have stood in the way of the successful development of this type of valve, but the design of an Australian inventor offers some hope of avoiding these troubles. At the time of the issue of the last annual report a six-cylinder automobile engine fitted with this type of valve had been tested, and a four-cylinder air-cooled aero-engine was being redesigned in order to incorporate this rotary valve. That engine has now been completed and tests are in progress. Up to now the valve has only been applied to liquid-cooled engines and air cooling has introduced many problems. It is believed, however, that the problems will be successfully solved. The severe design limitations found when applying the rotary valve to an existing engine have stressed the need for fundamental design data. This is most conveniently obtained on a single-cylinder engine, and the design of such a unit has now been completed by the Division and its construction is almost complete. The uses of Australian timber for aircraft construction have also been investigated.

Engineers and the British Empire

By Professor MIDDLETON SMITH, M.Sc., M.I. Mech. E., LL.D.

No. XIV—*(Continued from page 261, October 1st)*

Communications in Australia

THE outstanding feature of Australia is the fact that the important settlements cluster near the coasts. Marine transport has always been important for the movement of heavy goods. Mail and passengers were carried regularly by road from Sydney to Bathurst and Goulburn about 1838. Lennox built many fine stone bridges in the 1840s in New South Wales and Victoria. Little was done to construct permanent roads until 1850. There was coaching transport to the gold diggings about 1853. Then locomotives appeared and in 1924 the last coach was taken off the road and placed in the Queensland Museum.

By 1887 there were 2000 miles of macadamised roads in South Australia; in 1936 some 50,000 miles were open for traffic in the same state. In 1926, before flying became of much importance in the "outback" areas, there were roads connecting pioneer districts with the closely settled coast in all parts of the Commonwealth.

The absence of navigable rivers and the difficulties of increasing water transport by means of artificial waterways compelled the Australians in due course to build a large road and railway network. The average number of miles of railway per thousand inhabitants in the continent was 4·27 (1939), a figure only exceeded by Canada, which, in the latest record, can boast the greatest railway mileage per head in the world. On the other hand, Australia has only 9·26 miles of railway per 1000 square miles of country, which is one of the lowest figures recorded.

Before the war motor services ran over many routes, largely in conjunction with railway services, to provide regular transport to districts not served by railways, and there were many cross-country services linking one railway route with another. A five-day tour by car from Adelaide to Sydney *viâ* the Murray Valley cost under £5. In 1939 some 899,533 motor vehicles were registered in the Dominion. It was (1939) claimed that the relatively large number of motor vehicles, 124 per 1000 population, showed the high standard of living enjoyed by the people. Fleets of luxurious modern vessels allowed passengers to visit the principal ports. Many passengers travel by sea. There was a regular service between Melbourne and Darwin and from Fremantle to Darwin.

The mileage of railways open for general traffic (1939) was 27,998. Queensland had then the longest length of track, 6447 miles, but New South Wales has the greatest traffic, with Victoria second and Queensland third. Tasmania has only some 788 miles of line. The gauge is 3ft. 6in., gradients range to as high as 1 in 40, and the sharpest curves are 5 chains radius.

The first railway was built for a distance of 15 miles between Sydney and Parramatta in 1850; by 1859 there were 171 miles in Australia. Up to the year 1871 only about 80 miles per annum were built. A very active period was between 1881 and 1891, when the rate per annum was 593 miles, but of late years it had dropped to 174 miles per annum; in 1931 the total mileage was 27,700. A new Federal line (east to west) on the 4ft. 8½in. gauge, some 1051 miles long, was completed in 1917. It runs from Kalgoorlie to Port Augusta, through poor stock country, near the 10in. rainfall line nearly all the way. There was built also the so-called transcontinental line, 500 miles long (north and south), through a semi-desert, to honour the promise made by the Commonwealth that Adelaide and Darwin should be connected. In the war emergency a motor road has been built from the northern terminus of the line to Darwin.

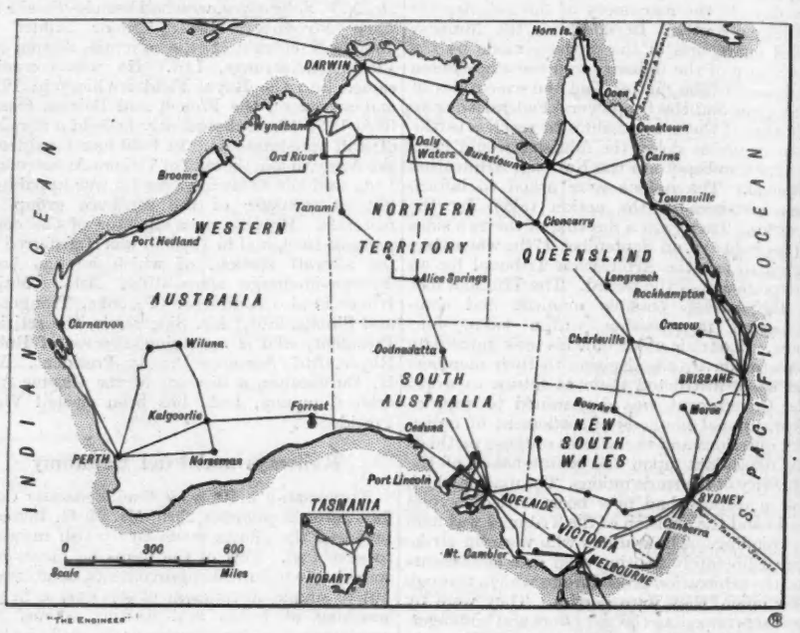
The discovery of gold and the consequent demand for heavy transport of goods of all types away from the seaboard created the demand for railways eighty years ago, for at that time the only alternatives were horse-drawn vehicles or bullock wagons. It soon became obvious to the Governments of the various states that they would have to finance and manage the railways. Naturally, the most highly developed sections of the country need the greater portion of the lines; these include the major portions of New South Wales and Southern Queensland, the whole of Victoria, the south-eastern part of South Australia, and the south-western corner of Western Australia. The latest figures (1938–39) show that nearly 385 million passengers and more than 33 million tons of goods for the year were carried. The total capital investment was £322 million; the gross revenue was £44,651,000; the loss (including capital charges) just over £4¼ million. It is considered that the loss on the railways is negligible as compared with their economic value; indeed, freight rates and fares are not fixed with a view to earning profits. There are various gauges in the different states, and so it is impossible to standardise railway stock, plant, or equipment. In the present emergency these railways are less effective than they might be for military purposes. It was estimated in 1921 that it would cost £100 million to establish a uniform gauge. In 1921 a special commission recommended the gradual conversion of all the lines to a 4ft. 8½in. gauge. Railways have been extended during the emergency of the war.

Road Construction

In 1940 there were about 280,000 miles of roads in Australia, which have cost about £150 million. Including those cleared only in a natural state, the total reaches nearly 500,000 miles. This was the result of a 160 years of effort by a relatively small population. These formed roads greatly assisted imports of motor vehicles and, in recent years, about one in ten of the population owned one. Of course, this rapid development of motor traffic has complicated railway finance; unified control of transport has been suggested.

Land transport has competed with marine transport and there was a considerable decrease at times in the tonnage of inter-state shipping lines. The overseas tonnage had remained fairly constant during the few years before the outbreak of war at between 5 and 6 million tons. By far the greater part was of British nationality and about 30 per cent. was divided amongst other nations.

From the railhead at Alice Springs the great north-south road now carries daily hundreds of tons of stores, &c., along a route where the passing of two motor-cars in one week was most unusual. It crosses wide depressions that tend to become swampy in the wet season. The construction of this 1000 miles of road during the war with Japan was an engineering feat of great magnitude; the workers lived hard in arid country, but after a time successful experiments were made to grow fruit and vegetables along the road. Small farms began to supply large quantities of produce to Army camps in the north; bore water irrigates the farms and experienced land workers from the ranks of the Army supplied labour. Camel teams, operated by aboriginals, take supplies from the road to outlying camps. Parts of the road are strengthened with tar and bitumen, and it is probable that now the whole 1000 miles of road is bitumenised. It must have a profound effect upon increasing the population in the areas served by it.



AIR ROUTES IN AUSTRALIA

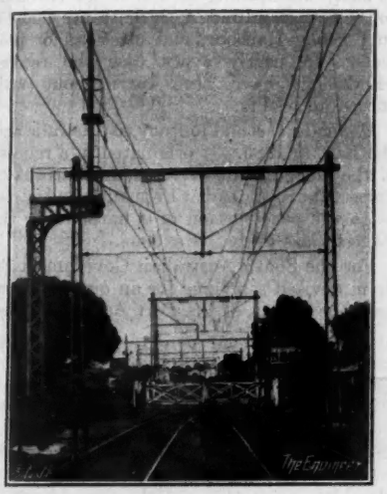
Melbourne Electric Railways

The track mileage of these suburban lines

is 300, but the traffic on them accounts for some two-fifths of the total train mileage of the railways entering Melbourne. The early residents laid out the city with great foresight, for the density of the population is only about one-fifth of that commonly found in this country. The suburban railways therefore cover an unusually large area, in spite of the excellent cable tramway system.

As far back as 1896 an American engineer proposed the electrification of the suburban system, suggesting the installation of three 225-kW "tramway dynamos" to work some of the lines. It was not until 1907, when Mr. (now Sir) Thomas Tait, Chairman of the State Electricity Commission, submitted a report of his tour in Europe and America, and engaged the late Mr. C. H. Merz as consulting engineer, that anything was done. After visiting Melbourne in 1908, Mr. Merz showed that it would pay to electrify the lines. It was not until 1912, when the traffic had increased much more than was anticipated, that contracts were placed for the gradual conversion of the system to high-tension D.C. traction. With the exception of the coach equipment, supplied by American firms, all of the contracts were placed with British or Australian manufacturers.

At the Newport A station power is



ELECTRIFIED RAILWAY NEAR SANDRINGHAM

produced at 3300 volts between phases by three-phase, 25-cycle, turbine-driven alternators, and raised to 20,000 volts by static transformers; transmission is to sub-stations, where it is converted to 1500 volts D.C., and at that voltage supplied to the trains by overhead contact wire. Work was started in November, 1913, and the first train was run in May, 1919; the war caused much delay.

The trains are operated on the multiple-unit system, every second or third coach being equipped with motors. All of the rolling stock was built at the State railway workshops at Newport. Each motor-coach has four motors of 140 H.P. with gear ratio so that the maximum speed is 52 m.p.h. on level tangent track.

The electrified Melbourne section of the Victorian railway system is not of great radius, the longest individual line extending a distance of 26 miles. The late war and other reasons caused an unfortunate delay in getting the scheme into operation, but in 1919 the power station Newport A was completed as a nucleus of a scheme for a cheap supply of power for the railway and future industrial development in the state. This station uses imported Newcastle black coal. The site chosen was at the mouth of the Yarra River; it was laid out for two similar power stations. The initial installation of six Parsons' turbines at Newport A had a total capacity of 68,000 kW, with six 350-kVA turbo-generators for starting up. Three-phase transmission at 20,000 volts supplied power to thirteen feeder sub-stations. There are 340 single-track miles, including sidings.

Air Services

There had been considerable activity in connection with air services, the lengths of which before the war totalled nearly 5000 miles.

In peacetimes there were airline services reaching Australia direct from Great Britain, from New Zealand, and from New Guinea and Papua. There were connecting services to the United States from New Zealand, and from Singapore and Batavia to China, Japan, and other Eastern countries. It was thus possible to reach Australia by air from practically any country in the world.

Tasmania has five channels of communication with the mainland, 200 miles distant. They are (1) ships, (2) submarine telegraphs, (3) wireless, (4) submarine telephone, (5) air liners.

Telegraphs, Cables, and Wireless

In 1859 Charles Todd, Superintendent of Telegraphs in South Australia, first suggested an overland telegraph line across the continent. He pointed out the advantages of thus linking north and south, if the cable authorities would extend their system to Java and across the Arafura Sea to Darwin. Todd carried out what was, in those days, a wonderful work by carrying a telegraph line 1970 miles long over most difficult country from Adelaide to Darwin. Most of the line was laid over an unsettled and almost unknown wilderness. White ants destroyed many of the wooden poles, but Todd replaced them with iron ones.

Nowadays, the world is accustomed to the rapid receipt of news, but when Todd worked to implement his scheme ships were the only means of communication between Britain and the Antipodes, and news from the other side of the world was months old on arrival. In June, 1870, the Government of South Australia pledged itself to have the line open two years later. An English company laid a cable to connect Darwin with the existing cable in Java, and in 1871 cable messages were coming through to Australia from London. In 1902 a cable was laid across the Pacific from Brisbane to Vancouver, giving a direct route to North America and an alternative route to Europe.

Australian Ports

The Federal Parliament makes laws with respect to trade and commerce with other countries and among the states, including navigation and shipping, and in relation to such matters as lighthouses, lightships, beacons and buoys, and quarantine.

The principal ports in Australia, together with the net tonnage of arrivals, including coastwise shipping, for 1938–39 are given below:—

STREAMLINED LOCOMOTIVE

Port.	Net tonnage.
Sydney	11,650,317
Melbourne	8,646,893
Port Adelaide	5,524,403
Newcastle	5,099,481
Brisbane	4,916,463
Fremantle	4,012,219
Townsville	1,473,008
Port Kembla	1,225,258
Hobart	1,153,143
Albany	510,807

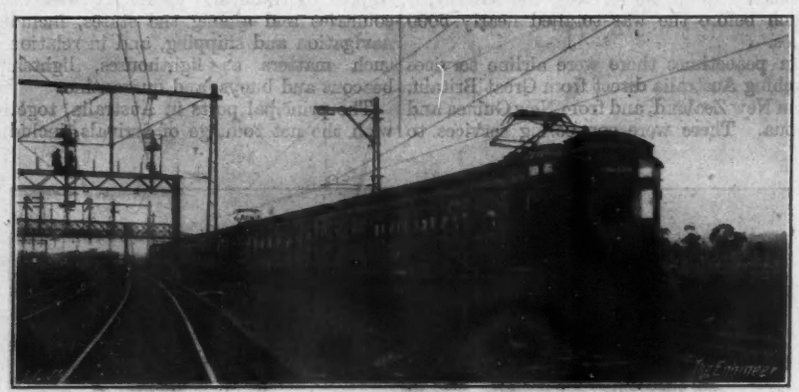
At that date the figures were for (1) London 30,777,000, (2) Liverpool 17,628,000, (3) Southampton 13,469,000, and (4) Glasgow 6,574,000.

The Port of Fremantle

By reason of its geographical position this port is the first and last place of call in Australia for vessels from Great Britain, Europe, Africa, and, in some cases, the Far East. It is situated on the Swan River and it is the western terminus of the Trans-Australian Railway. It is the chief port in Western Australia. Perth, the capital of that state, is also on the Swan River, about 12 miles distant. The harbour is well sheltered and is accessible by day and night at all times of the tide and in all weathers. There is ample depth of water, which permits of the safe manœuvring of deeply laden vessels. The largest ships trading to Australia are able to berth at the wharves.

Fremantle became a city in 1929, the celebrations reminding us that Captain Fremantle, of H.M.S. "Challenger," had landed, one hundred years earlier, near to the city and had taken possession of that portion of the continent. In that year twenty-one vessels, mostly trading, arrived at Fremantle. In December, 1845, the first steam vessel, H.M.S. "Driver," to arrive in Australia visited the port.

There was a rocky bar across the mouth of the river, so that entrance to the river for vessels of any size was impossible and a small jetty was erected in the bay. It was replaced by a much longer one, some 1400ft. in length, in 1873 and later the structure was extended to 3830ft. It was demolished in 1921.



SIX-COACH SUBURBAN TRAIN

As far back as 1839 the Surveyor-General submitted a design for an outer harbour, but it was not until 1856 that the proposal to open the mouth of the river was seriously considered. For years there was controversy concerning the respective merits of plans for an outer and an inner harbour. Many eminent authorities on harbour construction supported each of several proposals. Then, in 1891, a British engineer, the late Mr. C. Y. O'Connor, was appointed Chief Engineer of the state. He was a man of great personality and ability. He immediately turned his attention to the harbour problem, soon submitted designs which became the basis of the construction of the present harbour, and in 1892 work was begun.

In 1897 the rocky bar was sufficiently cleared to enable the first steamer (2062 tons gross register) to enter the port, but it was not until 1900 that the first British mail steamer reached the port. She was soon followed by others, including French mail steamers. No less than a million and a half cubic yards of rock were tipped into the sea to form two moles and three and a half million cubic yards of solid rock and nine million cubic yards of sand have been removed by blasting and dredging.

The outer harbour includes Gage Roads and Owen Anchorage. The former is a large area of water about 8 miles long and 5 miles wide. It is a good anchorage for vessels in all weathers. Owen Anchorage lies to the south of Gage Roads; it has a jetty used for discharging livestock and another where explosives are handled. The area of water within the outer harbour boundaries is about 114,000 acres.

The inner harbour comprises about 152 acres of land and 250 acres of water. It is within the estuary of the Swan River; it consists of an entrance channel and the inner harbour basin. The channel, about 5500ft. long and 450ft. wide at the outer entrance, is 800ft. wide where it joins the basin. The north and south moles, armoured rubble breakwaters, are respectively 4835ft. and 2040ft. long; they protect the channel on both sides. The inner harbour basin is a dredged area, 5000ft. in length with a width from 800ft. to 1400ft., the latter width being maintained over a length of 3300ft. There is excellent wharf accommodation, efficient cargo handling equipment, together with commodious cargo and grain sheds. In the inner harbour there are 10,000 lineal feet of berthage space. The wharves were built originally entirely of timber, but concrete piles have replaced the old wooden ones.

A body corporate, the Fremantle Harbour Trust, has the exclusive control and administration of the harbour. The Governor of the state appoints triennially five Commissioners, the principal executive officers being the manager and secretary. The largest vessel that has entered the inner harbour was H.M.S. "Hood" (1924), of 45,000 tons, 861ft. long and with a draught of 33ft. In 1930 a deeply laden vessel, with a draught of 34ft. 7in., entered.

Melbourne and Adelaide

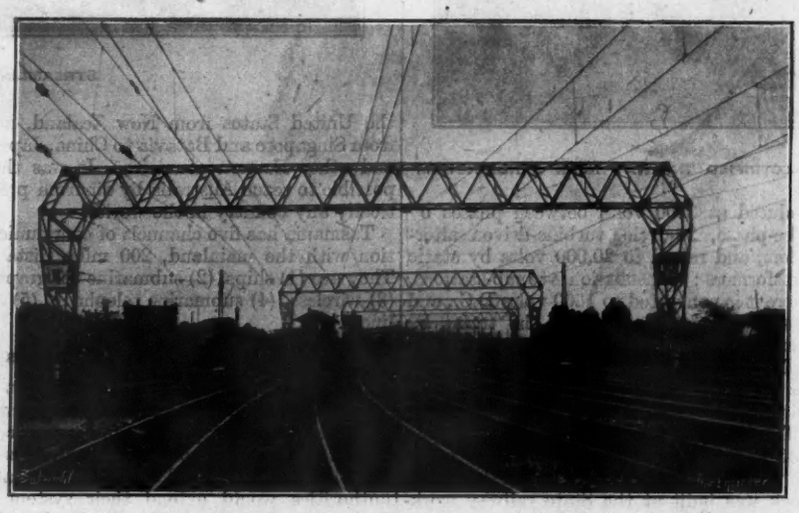
These and other Australian ports and harbours have been improved by developments planned by consulting engineers in London. In 1878 Sir John Coode, acting for the Melbourne Harbour Trust Commissioners, made a personal inspection of Port Phillip and the River Yarra and designed extensive improvements for the Port of Melbourne. The works recommended consisted mainly of the rectification, widening, and deepening of the river, in order that the largest class of vessels might eventually be enabled to reach the city, where docks and wharves were to be provided. The provision of relief in time of flood was closely connected with the harbour question; on this point great difference of opinion existed in the colony, several prominent local authorities being in favour of a new direct canal from the river at Melbourne to Hobson's Bay.

Sir John Coode, however, insisted strongly on the improvement of the existing channel and river mouth as the only way of retaining the advantage derived from the upland and tidal waters of the Yarra and of an effluent which enters it at a point some miles below the city. His arguments convinced the Commissioners and shortly after the report was handed in they adopted the recommendations, the most important of which have since been carried out. The island, formed by a new cut recommended by Sir John, to eliminate an exceptionally tortuous bend in the old river channel, was officially named Coode Island.

At the request of the Government of Victoria he reported on harbours at Portland and Warrnambool, river improvements at Belfast, the opening of a new sea entrance to the Gippsland Lakes, the entrance channel to Geelong Harbour, and other minor projects. In nearly every case the recommendations have been carried out with successful results.

He made a second journey to Australia and the East in 1885. It originated in a request of the Government of Western Australia to inspect the roadstead at Fremantle and advise as to the construction of a harbour for the largest class of mail steamers.

For the South Australian Government Sir John devised a scheme for an outer harbour near the mouth of the Port Adelaide River.



ELECTRIFIED RAILWAY, NORTH MELBOURNE

For the New South Wales Government he inspected several rivers; the harbours of Port Macquarie, Wollongong, and Kiama; the entrance to Lake Macquarie; and the wharfage in Darling Harbour, Sydney. For most of these ports he subsequently submitted designs. Finally, for the Queensland Government, he inspected and afterwards designed works for improvements at Rockhampton, Mackay, Townsville, and the bar of the Norman River.

(To be continued)

John Henry Hamilton and the Positive Scavenging Engine

By A. K. BRUCE

No. I

AMONG the records of patent litigation there are few—if, indeed, there are any—which, relating to internal combustion engines, possess higher interest than that attaching to the case of Otto *v.* Steel in 1885–86. For eighteen days did this famous action occupy the Chancery Division of the High Court of Justice, the judge being Mr. Justice Pearson. Steel admitted infringement of Otto's patent (No. 2081 of 1876), but alleged that the patent was invalid on the grounds of the insufficiency of the specification and anticipations.

It is not here intended to go over the arguments submitted by perhaps the most formidable array of counsel and engineers ever gathered together for a single case, or to deal with the very interesting judgment uttered by Mr. Justice Pearson, a judgment which reads, in places, like a declaration by Athanasius on some point of theological doctrine. The matter of interest to us in the present memoir is the discussion which raged round the first of Otto's claims. This was for "Admitting to the cylinder a mixture of combustible gas or vapour with air separate from a charge of air or incombustible gas so that the development of heat and the expansion or increase of pressure produced by the combustion are rendered gradual." Were the contents of this cylinder prior to ignition "homogeneous" or "heterogeneous," and should the "residuum" be got rid of or retained? It is only of philological interest to record that the learned judge found that "the mixture is heterogeneous and not homogeneous," but it is of practical interest to note that Mr. Justice Pearson, dealing with the citation by the defendant of Barnett's patent No. 7615 of 1838 (one of the most important patents in the history of the internal combustion engine) should have maintained that Barnett did not anticipate Otto for the reason that, whereas Otto desired to retain the "residuum," Barnett desired to get rid of it. To be precise, the judge remarked that he came to the same conclusion as did the Court of Appeal in the case of Otto *v.* Linford, "namely, that if Barnett does anything by this patent, it is to tell you to get rid of the residuum instead of retaining it." Barnett was an ironfounder in Brighton, and he describes his single-acting gas engine as equipped with "a double-acting pump, which serves both to supply atmospheric air (to form one portion of the explosive mixture) and to draw off from the cylinder, during the descent of the piston, the products or any portion of the unconsumed gas which may remain after the explosion of the mixture has taken place." In connection with his double-acting gas engine, Barnett explains that "If preferred, the eduction pipe may be connected to a double-acting air pump, so as to exhaust the products of the explosion, or any unconsumed portion of the explosive mixture from the cylinder on the eduction side of the piston." The learned judge was right in pointing out that Barnett did not anticipate the first claim in Otto's patent, but subsequent experience has proved that Barnett, in 1838, knew much more about the effect of the "residuum" than did Otto in 1876.

Otto's patent was, indeed, weak in both legs, since while the first claim was bottomed in a fallacy, the second claim was just an echo of what had already been described and patented by Beau de Rochas. Otto himself was quite sincere in his belief that the first claim was sound, and in the evidence which he gave during the hearing of the action against Steel we find the following passage: "No doubt a certain portion of the gas from the charge penetrates the residuum, and if it did not do so my claim would be useless, and my patent an absurdity, and it is simply because some of the gas does penetrate the residuum, and that I am able, therefore, to burn it at a later period, that my patent is a useful patent, and that my claim altogether is feasible." Otto was not alone in his views as to the utility of the residual products and it must be remembered that he was trained as a business man rather than as an engineer, and this may partly account for the obstinacy with which he adhered to his ideas on stratification. The conception of the existence of more or less quiescent layers of dissimilar gas and air mixtures in the combustion chamber of a compression gas engine would not have survived drastic experimental inquiry, since the actual conditions are those of a typhoon rather than a zephyr. The good performance of the Otto engine was not due (as Otto supposed) to any stratification of the charge, but to (1) the use of the Beau de Rochas cycle, (2) compression of the charge prior to ignition, (3) accurate manufacture. Otto and his partner Langen were the first to translate these features into a mechanical and commercial success, and as long ago as 1881 tests made on Otto engines showed them to be operating with an indicator thermal efficiency of 16 per cent. and a mechanical efficiency of 87 per cent.

The maintenance in Great Britain of a monopoly in the Otto engine acted as a strong stimulant to the ingenuity of gas engine designers. The same incentive had operated in Germany until it was shown, to the satisfaction of the German courts, that the Otto patent was invalid for the very weighty reason that it lacked originality. So long as the Otto patent held good in Great Britain (where it was defended with great vigour), the four-stroke cycle engine could only be built by one firm. Hence ensued the flood of patents covering compression gas engines ranging from mechanical curiosities to highly ingenious and practical machines. Among the most conspicuous of these was unquestionably that patented by Charles Linford, of Leicester, whose application is dated January 24th, 1880 (patent No. 330). Debarred from using the four-stroke cycle, Linford found what he realised would be a workable alternative by adding two further strokes, his solution being therefore a six-stroke cycle, the stroke following the normal exhaust stroke being used for inhaling a cylinder full of air, this air being expelled by the succeeding stroke. That Linford had a full grasp of the importance of the scavenge is well demonstrated by the first claim in his patent:—"The employment of a distinct and separate current of atmospheric air as a scavenger for washing out or clearing the cylinder of a gas engine (single or double) from any remaining residues of combustion after the usual exhaust, said separate current of air being sucked into and discharged from the cylinder by the working piston or pistons without the aid of pumps or other extraneous appliances or apparatus for charging the cylinder with said air."

Six and a half years after the date of Linford's patent, Arthur Rollason, who had been an inspector of gas meters, applied for a patent (No. 7427/1886) which described a gas engine operating with a six-stroke cycle and arranged to utilise heat generated by the explosion in order to raise the temperature of a subsequent charge. The patentee states, *inter alia*, that "in the Otto gas engine a large amount of energy is wasted by reason that the combustion is not complete until nearly the end of the stroke, and indeed in some cases the charge is exhausted before the complete combustion has been been effected." There are five claims, and the patent is the one upon which was based the "Beck" engine. It is in the highest degree probable that as Rollason was not an engineer, the provisional and final specifications, as well as the drawings, were the work of John Henry Hamilton, the subject of the present memoir. Hamilton, when designing the "Beck" engine, seems to have been more interested in the regenerative feature than in anything else, and it may be noted that the complete specification of the patent makes mention of Charles William Siemens' patent No. 2074 of 1860, which describes a form of the regenerative engine. Whatever may have been his views, at the time, as to the significance of the scavenge, Hamilton did not (as some have supposed) originate the six-stroke cycle. His use of it at all was solely because, like Linford, he found himself debarred from adopting the four-stroke cycle.

Prior to the date of the patent for the "Beck" engine, James Atkinson, in his "Differential" gas engine of 1885, had recognised the desirability of driving out the residual products of combustion, irrespective of the degree of inflammability of the charge, and was clearly of the opposite opinion to Otto in this matter. He also made tests on his "Cycle" gas engine (patented in 1886), which demonstrated beyond all question the advantage of scavenging out the residual products. In these tests the displacement of the products of combustion was effected by restricting the clearance. On what research Otto may have founded his conclusions as to the effect of the residuum has not been related, but Atkinson made tests with ordinary town gas on a "Cycle" gas engine with a connecting-rod which could be fixed to two different centres. Working on one of these centres, the products of combustion were driven out. Working on the other left a space equal to about 30 per cent. of the swept volume. In this way he found that in the same engine and with similar gas, the consumption was about 25·7 cubic feet per B.H.P. per hour when the products were not driven out, this consumption falling to 22·11 cubic feet per B.H.P. per hour when all the products were driven out, with the exception of so much as remained in the comparatively negligible working clearance space between the end of the piston and the end of the cylinder and in the valve cavities, &c. These tests by Atkinson—which, as it will be noted, disclosed a saving in gas consumption of nearly 14 per cent.—are the earliest known to the present writer in which a scientific degree of attention was given to research on the influence of scavenging in gas engines. Gottlieb Daimler, in his patent No. 4315/1885, also disclosed, like Atkinson, a sound knowledge of the advantages to be derived from efficient scavenging, though the arrangement which he describes would not be applicable to other than small engines,

nor is it on record that the scavenging device which he claimed was ever put into actual commercial production on his own or any other engines.

It is entirely probable, moreover, that Beau de Rochas was aware of the importance of the matter. In his famous memorandum, this most prescient Frenchman (describing the function of the fourth stroke of his cycle) uses the words: "Refoulement des gaz brûllés hors du cylindre" (expulsion of the burned gases from the cylinder). Beau de Rochas, however, did not describe any means for scavenging other than by the motion of the piston.

Linford, Atkinson, and Daimler were not the only gas engine designers, who, like Barnett much earlier, occupied themselves in devising arrangements whereby they might improve the scavenge. In 1887 Harold Heron Hosack applied for a patent (No. 888) describing, among other things, a system according to which the expulsion of the whole of the products of combustion is effected by "(1) causing a body of air to enter the cylinder behind the piston at the outer end of its stroke, and force out a portion of the products of combustion through the exhaust port at the opposite end of the cylinder, and (2) then expelling the remaining products of combustion by the return, or next inward stroke of the piston." Though his engine was of four-cycle type, Hosack scavenged it by crank chamber compression, ports formed in the cylinder wall being uncovered at the outer dead centre. "I prefer," he says, "to introduce a portion of the air into the cylinder or cylinders behind the piston when at or near the outer end of its stroke. By this means I facilitate the expulsion of all the products of combustion, thereby obtaining a pure charge of air or gas within the cylinder." Hosack had a very thorough grasp of the importance of getting rid of the residual products, remarking (in his complete specification) that "the effect of the absence of products of combustion is that a more perfect combustion and a 'higher diagram' is obtained, than in engines in which a proportion of products of combustion remain in the cylinder for a given quantity of gas." In the six-cycle engines of Linford, Hamilton, and others, the additional strokes effected the scavenging and the charging of the engine by a method which much reduced the output obtainable from a given cylinder at given crankshaft speed, and thus increased the cost and weight of the engine. Hosack's proposal dispensed with the additional strokes, but it still remained for someone to provide a mechanical solution which, without requiring crank chamber compression and ports in the cylinder wall, could deal with the residual products at the point where the piston left off, *i.e.*, towards the end of the exhaust stroke. Nevertheless, Hosack's patent gives an early description of the forced scavenging of a four-cycle engine by means of air admitted to the engine cylinder for the specific purpose. Incidentally, patent No. 888/1887 is important for another reason, since Hosack describes—apparently for the first time—an arrangement whereby gas is injected into the engine cylinder at or near the end of the compression stroke.

Examination of gas engine patents applied for in Great Britain during the life of the British Otto patent reveals the ingenuity of those inventors who devoted themselves to arriving at means whereby the advantages of the Beau de Rochas cycle of operations could be attained without the hazard of an action for infringement of the Otto patent. Litigation in connection with engines built by Linford was taken to the Court of Appeal, which decided in favour of the Otto patent. This is referred to by Professor William Robinson as "a great blow to the gas engine industry in this country." As has already been mentioned, the existence of the Otto patent was really a stimulus to inventors. This stimulus to the evolution of other types collapsed immediately the British Otto patent expired, since gas engine designers were then able to use the four-stroke cycle without fear of molestation. It was at this juncture that Hamilton published his solution of the problem of improving the performance of the Beau de Rochas or Otto engine without departing from its general simplicity.

Prior to the expiry of the Otto patent, Hamilton had, as has already been related, designed the "Beck" engine. Tests on this engine demonstrated not only that the mean pressure could be increased, but that the higher mean pressure could be maintained indefinitely. These effects were consequent partly on increasing the size of the gas ports and on other refinements in design, but chiefly on the expulsion of the hot residual gases and the reduction of internal surface temperatures resulting from the scavenge. Since the surprisingly good performance of the "Beck" engine was due mainly to the fifth and sixth strokes of the piston, Hamilton realised that a reversion to the four-stroke cycle plus a scavenge pump would produce the same result as regards mean pressure, while simultaneously enabling a far greater output to be taken from a given cylinder size. It was this reasoning which led him to the positive scavenging four-cycle gas engine.

It is to be noted as a coincidence that just at the time Akroyd Stuart, labouring to prevent pre-ignitions and back-firing in the four-cycle oil engine, hit on the idea of adding the fuel to the air at the end of compression, Hamilton, working on the four-cycle gas engine, arrived at the positive scavenge. The trouble with the early Hornsby-Akroyd engines (which were not built in accordance with Akroyd Stuart's compression ignition cycle and had, moreover, a comparatively large clearance volume) was due—according to J. W. Young's authentic account of the matter—to the "presence of incandescent exhaust gas left over in the vaporiser from the previous working stroke, which fired the oil charge during the next suction stroke, consequently the cylinder contained no combustible matter during the compression stroke." Mr. Young adds that "the trouble loomed so large that it nearly led to the abandonment of the engine." The difficulty was not confined to any particular design of internal combustion engine, but applied more or less appreciably to all engines in which an inflammable or explosive mixture was compressed. It affected not only the mechanical operation, but set a very definite limit to the compression pressure and mean effective pressure, and thus to the power obtained from the engine, and the heat efficiency with which it operated.

(To be continued)

Change-Gear Calculations

By H. E. MERRITT, D.Sc.

THE general problem which arises in the calculation of a change-gear combination can be stated thus: Given a ratio r determined by particular requirements and calculated as a decimal quantity that cannot conveniently be expressed as a proper or vulgar fraction, to find a proper fraction m/n having a value sufficiently close to r and also having a numerator and denominator both of which can be factorised into numbers representing the numbers of teeth of convenient change gears.

Many methods of solving this problem have been advanced. That most commonly used in workshops is based on the properties of continued fractions, but it does not necessarily give the quickest or most accurate solution or reveal all the alternative fractions nearest to the desired value. Other methods have been published by Brocot, Rasche, and Lancaster, and the one presented in this article is a new combination of all of these. It is designed for workshop use; it is therefore described and explained in the simplest terms and assumes on the part of the reader no prior knowledge of the properties of fractions.

Conjugate Fractions

A *proper fraction* is a fraction having a value less than 1, in which the numerator and denominator have no common factor.

Two proper fractions are said to be *conjugate* if the difference between them is equal to 1 divided by the product of their denominators. Thus, if a/b and c/d are proper fractions, they are conjugate if

$$a/b - c/d = 1/b\,d,$$

or, what amounts to the same thing, if

$$a\,d - b\,c = 1.$$

In the method here described it is presupposed that the value of r, to which an approximation by a fraction has to be found, is expressed as a quantity less than 1. (If the calculation of the ratio gives a quantity greater than 1, its reciprocal is taken as r and the final result inverted.)

The Brocot Table

If the denominator does not exceed a certain value (termed the "base"), there is only a finite number of proper fractions. If these fractions are arranged in order of magnitude, and the decimal equivalents given, the result is a Brocot table. That given below is a Brocot table to base 10, and is included in order to illustrate the method by simple examples.

Numerator.	Denominator.	Value.
9	10	0·900000
8	9	0·888888
7	8	0·875000
6	7	0·857142
5	6	0·833333
4	5	0·800000
7	9	0·777777
3	4	0·750000
5	7	0·714285
7	10	0·700000
2	3	0·666666
5	8	0·625000
3	5	0·600000
4	7	0·571428
5	9	0·555555
1	2	0·500000
4	9	0·444444
3	7	0·428571
2	5	0·400000
3	8	0·375000
1	3	0·333333
3	10	0·300000
2	7	0·285714
1	4	0·250000
2	9	0·222222
1	5	0·200000
1	6	0·166666
1	7	0·142857
1	8	0·125000
1	9	0·111111
1	10	0·100000

For practical purposes a more extensive table (*i.e.*, to base 100 or 120) is required.

Such tables are to be found in many publications for workshop use.

In any Brocot table every fraction is conjugate to its neighbour. This will be seen to be true by testing any pair of consecutive fractions. Taking the fractions 3/4 and 7/9 in the table above, for example,

$$a/b=7/9 \qquad c/d=3/4$$
$$a\,d-b\,c=7\times4-9\times3$$
$$=28-27$$
$$=1$$

It should be noted, however, that there are other fractions, apart from consecutive fractions, which are conjugate to each other. There is, in fact, an infinite number of fractions conjugate to any given proper fraction. For reasons explained in a subsequent paragraph, any two fractions in a Brocot table can be identified as conjugate if their denominators are both smaller than that of every intermediate fraction. Thus, between the fractions 1/2 and 1/3 in the table, the denominator of every intermediate fraction is greater than 3, and 1/2 and 1/3 will be seen to be conjugate. Similarly, 1/2 is conjugate to 2/5, 3/7, 4/9, . . .

It will be assumed throughout this article that a/b is greater than c/d; further, that a/b and c/d are conjugate fractions, the first greater and the second less than the desired value of r. In other words,

$$a/b,\ r,\ c/d$$

are arranged in descending order of magnitude. The values of a/b and c/d on either side of any particular value of r can readily be located in the Brocot table.

Properties of Conjugate Fractions

The most important property of conjugate fractions is that no fraction intermediate in value can have a denominator less than that of either of the conjugate fractions. For the difference between a/b and c/d is

$$\frac{a\,d-b\,c}{b\,d}$$

and since a, b, c, and d are whole numbers, $a\,d-b\,c$ must be a whole number. It cannot be zero unless $a/b=c/d$ (which is excluded), and the smallest value of $a\,d-b\,c$ is therefore 1. For given values of b and d the smallest difference between the fractions is therefore $1/b\,d$. If any fraction is intermediate in value between a/b and c/d the difference between it and its neighbour must therefore be smaller than $1/b\,d$; hence the product of the denominators must be greater than $b\,d$ and the denominator of the intermediate fraction must be greater than either b or d.

By similar reasoning it can be shown that of all the fractions intermediate between a/b and c/d that having the smallest denominator is

$$\frac{a+c}{b+d.}$$

This fraction is conjugate to both a/b and c/d. For, applying the test for conjugate fractions,

$$\frac{a}{b}-\frac{a+c}{b+d}=\frac{a\,(b+d)-b\,(a+c)}{b\,(b+d)}$$
$$=\frac{a\,d-b\,c}{b\,(b+d)}$$
$$=\frac{1}{b\,(b+d)}$$

and similarly

$$\frac{a+c}{b+d}-\frac{c}{d}=\frac{1}{(b+d)\,d}$$

The General Intermediate Fraction

Assuming that the conjugate fractions a/b and c/d nearest to the desired ratio of r have been located in a Brocot table, the problem is to find an intermediate fraction m/n approximating to r with sufficient accuracy and having suitable factors. This will almost inevitably require a process of trial and error which may be expressed as follows:—That it is necessary to build up a sequence of fractions

$$a/b\ m_1/n_1\ m_2/n_2\ \ r\ \ m_3/n_3\ m_4/n_4\ c/d$$

limiting the choice of fractions m_1/n_1, m_2/n_2, &c., to those falling between predetermined limits of accuracy and having the smallest denominators in order to facilitate factorisation. Representing any fraction between a/b and c/d by m/n, it can be expressed in general by

$$\frac{m}{n}=\frac{a\,y+c\,z}{b\,y+d\,z}$$

where y and z are any positive whole numbers.

It is easy to show that every such fraction is intermediate between a/b and c/d by taking differences. Thus

$$\frac{a}{b}-\frac{m}{n}=\frac{a}{b}-\frac{a\,y+c\,z}{b\,y+d\,z}$$
$$=\frac{a\,(b\,y+d\,z)-b\,(a\,y+c\,z)}{b\,(b\,y+d\,z)}$$
$$=\frac{z\,(a\,d-b\,c)}{b\,(b\,y+d\,z)}$$
$$=\frac{z}{b\,(b\,y+d\,z)}$$

This quantity must be positive, and therefore m/n must be less than a/b. It follows in a similar way that m/n is greater than c/d. Thus, having found first approximations to the desired ratio r in the fractions a/b and c/d, the problem is now that of finding values of y and z which will give a still closer, and adequate, approximation when inserted in the general expression for m/n. Clearly, y and z must be as small as possible in order to give correspondingly small numbers in the numerator and denominator of the fraction m/n and thus increase the chances of finding suitable factors.

Now if $y=z$, the intermediate fraction is $\frac{a+c}{b+d}$; if y is greater than z, m/n approaches a/b; and if y is less than z, m/n approaches c/d. Thus the direction in which the value of m/n moves will depend upon the ratio of y to z. This ratio will be a proper fraction if the smaller is the numerator, and for the moment it will be assumed that y is the smaller. The proper fraction y/z will now be termed the "auxiliary fraction."

Conjugate Auxiliary Fractions

It is most improbable that in any particular example there will be a value of the auxiliary fraction which will give precisely the desired value of r. It will only approximate to an ideal ratio x found from

$$r=\frac{a\,x+c}{b\,x+d}$$

whence

$$x=\frac{d\,(r-c/d)}{b\,(a/b-r)}$$

and the closer the agreement between x and y/z the more nearly will the corresponding fraction m/n approach r.

Hence, if in the expression for m/n are substituted two values of the auxiliary fraction, one greater and one less than x, the resulting values of m/n will be respectively greater and less than r.

Observe the parallel between the first and second stages in the problem. In the first, two conjugate fractions were found, respectively greater and less than r, viz.,

$$a/b\ \ r\ \ c/d$$

In the second, it is required to find two fractions respectively larger and smaller than a ratio x. Let these be written y_1/z_1 and y_2/z_2. Arrange them

$$y_1/z_1\ \ x\ \ y_2/z_2$$

and complete the parallel by making y_1/z_1 and y_2/z_2 conjugate. As in the first stage, these fractions can easily be obtained by selecting adjacent fractions from a Brocot table, on either side of the calculated value of x. The strange result of doing this is that *the corresponding fractions* m_1/n_1 *and* m_2/n_2 *are also conjugate.*

This can be demonstrated in the usual way. Thus

$$\frac{m_1}{n_1}=\frac{a\,y_1+b\,z_1}{b\,y_1+c\,z_1}$$
$$\frac{m_2}{n_2}=\frac{a\,y_2+c\,z_2}{b\,y_2+d\,z_2}$$
$$\frac{m_1}{n_1}-\frac{m_2}{n_2}=\frac{a\,y_1+c\,z_1}{b\,y_2+d\,z_2}-\frac{a\,y_2+c\,z_2}{b\,y_2+d\,z_2}$$

and this reduces to

$$\frac{1}{(b\,y_1+c\,z_1)\ (b\,y_2+d\,z_2)}$$

showing that m_1/n_1 and m_2/n_2 are conjugate.

What is the significance of this? It is that by one calculation of x and two references to a Brocot table, there are derived two fractions which are very close to r, have relatively small denominators, and can be used to find other fractions if neither of them is itself good enough.

To Find the Smallest Conjugate Auxiliary Fractions

It is now necessary to diverge a little from the preceding argument in order to discuss means for reducing still further the magnitudes of the denominators.

As pointed out by Rasche, a change-gear ratio should, like any other dimension, be subject to a tolerance. Suppose therefore that instead of a single value for the ratio r, upper and lower limits r_1 and r_2 are determined. There will then be corresponding upper and lower limits for the auxiliary fraction given by

$$x_1=\frac{d\,(r_1-c/d)}{b\,(a/b-r_1)}$$
$$x_2=\frac{d\,(r_2-c/d)}{b\,(a/b-r_2)}$$

When x_1 and x_2 have been calculated, a Brocot table can be referred to and the fractions with the smallest denominators within these limits found by inspection. These fractions will automatically be conjugate, and when they are inserted in the expressions for m_1/n_1 and m_2/n_2 the resulting fractions will be conjugate, *and will have the smallest denominators of all fractions lying within the limits of* r_1 *and* r_2.

Expansion of Sequence of Fractions

Now suppose (as usually happens) that neither of the fractions m_1/n_1 and m_2/n_2 thus found can conveniently be factorised. It is then necessary to derive additional fractions within the limits of r and to test them in turn for factors. These fractions can be derived very easily, for by inserting any auxiliary fraction between the limits of y_1/z_1 and y_2/z_2 in the expression for m/n, a new fraction will be obtained lying within the limits of r. All such fractions together form a new Brocot system, since each is conjugate to its neighbour. Auxiliary fractions for trial can be chosen at random from the Brocot table (within the defined limits), and clearly those having the lowest denominators would first be used. Equally clearly, those lying nearest

the value of x corresponding to the original value of r will give the most accurate results.

Summary of Procedure

The foregoing exposition has been made rather lengthy in order that the underlying principles may be understood, but the actual work involved in any particular example is relatively little. It may be summarised as follows:—

(1) Determine from the circumstances of the case the desired value of the ratio r (expressed as a proper fraction), and thence allocate upper and lower limits r_1 and r_2 respectively.

(2) Using a Brocot table, find the consecutive fractions a/b and c/d on either side of r and in descending order of magnitude. (If a/b or c/d happens to be inside one of the limits of r, ignore that limit and substitute r.)

(3) Calculate

$$x_1=\frac{d\,(r_1-c/d)}{b\,(a/b-r_1)}$$

$$x_2=\frac{d\,(r_2-c/d)}{b\,(a/b-r_2)}$$

If both x_1 and x_2 are greater than 1, see below. If either x_1 or x_2 is greater than 1, write it as 1.

(4) Using a Brocot table, locate conjugate fractions y_1/z_1 and y_2/z_2 (in descending order), having the smallest denominators within the limits x_1 and x_2.

(5) Calculate the conjugate intermediate fractions

$$m_1=\frac{a\,y_1+c\,z_1}{b\,y_1+d\,z_1}$$

$$m_2=\frac{a\,y_2+c\,z_2}{b\,y_2+d\,z_2}$$

(6) Try these for factors. If these are found, they provide a solution within the limits of r. If not, insert any other fraction from the Brocot table between y_1/z_1 and y_2/z_2, and test for factors, repeating until a solution is found.

(7) If x_1 and x_2 are both greater than 1, write

$$y_1/z_1=1/x_1$$

$$y_2/z_2=1/x_2$$

and instead of (5) above, use

$$m_1=\frac{a\,z_1+c\,y_1}{b\,z_1+d\,y_1}$$

$$m_2=\frac{a\,z_2+c\,y_2}{b\,z_2+d\,y_2}$$

In this case, the larger value of y/z will give the smaller value of m/n.

Example

A numerical example is added, simplified beyond practical limits in order to reduce the amount of figuring and using the table to base 10 given previously.

(1) Let r have a calculated value of 0·606 with a tolerance of $\pm$0·001. Then r_1=0·607, r_2=0·605.

(2) From the table,

$$a/b=5/8=0\cdot625$$

$$c/d=3/5=0\cdot600$$

(3) Finding the limits of x

$$x_1=\frac{5\,(0\cdot607-0\cdot600)}{8\,(0\cdot625-0\cdot607)}=\frac{5\times0\cdot007}{8\times0\cdot018}=0\cdot243$$

$$x_2=\frac{5\,(0\cdot605-0\cdot600)}{8\,(0\cdot625-0\cdot605)}=\frac{5\times0\cdot005}{8\times0\cdot020}=0\cdot156$$

(4) From the table it will be seen that the fractions 1/6, 1/5 and 2/9 all lie within the limits. Choosing those with the lowest denominators,

$$y_1/z_1=1/5$$

$$y_2/z_2=1/6$$

(5) The conjugate intermediate fractions are

$$\frac{m_1}{n_1}=\frac{5\times1+3\times5}{8\times1+5\times5}=\frac{5+15}{8+25}=\frac{20}{33}=0\cdot60606$$

$$\frac{m_2}{n_2}=\frac{5\times1+3\times6}{8\times1+5\times6}=\frac{5+18}{8+30}=\frac{23}{38}=0\cdot60526$$

Even in this very simple example, using fractions to base 10, the better result departs from the mean value of 0·606 by only 1 in 10,000. If a full Brocot table to base 100 is employed, a correspondingly closer degree of approximation is obtained with but little extra trouble.

A Unified System of Boiler Control

THE paramount importance of fuel economy as a wartime need has directed attention to means for bringing the operation of industrial works boilers into line with modern power station practice, through the introduction of positive control to the auxiliary services. A recent development in this direction is the adaptation of the unified system of combustion control, first applied by the Metropolitan-Vickers Electrical Company, Ltd., to large power stations some years ago, to commercial works and utility plant boilers rated at from 10,000 lb. to 20,000 lb. per hour steaming capacity.

Complete combustion control in a boiler plant can only be achieved by adjusting the relative rates of flow of the several operating services to one another. These relative flow rates all fluctuate with the load demand in accordance with a common law of variation, and with electrical control it is an easy matter to adjust the speeds of the auxiliary motors to follow this common law under certain design conditions, provided each service has its own electric drive and the motor is subject to speed regulation. Under these conditions the boiler plant services can be placed under centralised control for normal working, and the individual services can be trimmed to meet any change in the operating conditions. The principal operating services for combustion are those for fuel, primary and secondary air supplies, flue gas exhaustion, and ash discharge.

Unification of Control

Co-ordination of boiler services to give correct unification of control is arranged by building into the motors of the auxiliaries special windings in order that each service will follow the correct rate to produce the desired quantity of fuel, air and gases for complete and efficient combustion, particulars of which are supplied by the boiler designers. They are indicated by the "boiler requirements" curve on the appropriate operating service chart, one of which is shown in Fig. 1. To meet these requirements over the total range of boiler load the motor speed needs some adjustment to follow the more or less common line of control.

A D.C. generator supplying the armatures of all the motors, with a rheostat in the field of the generator, gives complete regulation from zero to full speed. The field coils are mainly energised from a separate constant-voltage generator, and by introducing subsidiary field coils from the variable voltage with shunt or series windings supplementing or opposing the main coils, the speed curves can be designed to give the boiler requirements with operation of the main generator rheostat only.

In establishing the common line of control (armature voltage line) it is obviously most economical to take the largest motor (the induced draught fan). Therefore in Fig. 1 the speed and the boiler requirements follow the same line and the induced draught fan motors will be to standard motor design, the special

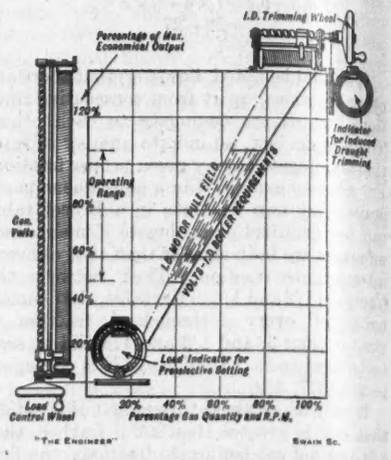


FIG. 1—OPERATING SERVICE CHART

field coils being fitted to the motors where required. With the field poles designed to give these corrections, the boiler can be controlled to give any desired load with optimum efficiency by the operation of a single rheostat control wheel.

The main advantages of this arrangement are that only one control hand wheel, one supply to each boiler, and one electrical control unit

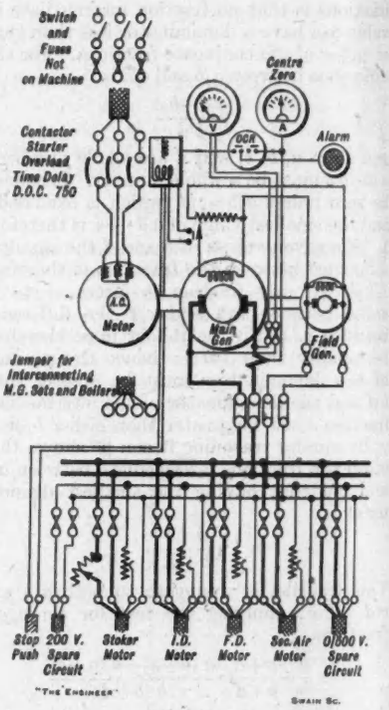


FIG. 2—ELECTRICAL CONTROL SYSTEM

are necessary. All damper control, variable couplings, starters, regulators, &c., can be dispensed with. No electrical equipment other than the specially designed motors is required on the fan floor. Full interchangeability between boilers is provided, with complete control from no load to full load and quick shutting down by electrical braking.

Electrical Control System

Load control of all the boiler services is effected by the main control hand wheel

(Fig. 1) operating a potentiometer type rheostat in the main generator field (Fig. 2), whilst a position indicator (Fig. 1) allows for preselective setting. Provision is made for trimming the various services to meet any departure from the designed boiler requirements. For example, the system resistance of the boiler will alter with the sooting of the passages; the combustion requirements will vary with changes in the constitution of the fuel.

Such necessary adjustments are carried out by means of trimming hand wheels with presetting indicators (Fig. 1), which operate potentiometer type rheostats in the fixed-voltage supply to the field windings of the service motors (Fig. 2). It is claimed that the forced draught fans can be kept within 2 per cent. of the boiler requirements with up to 30 per cent. trimming of the full motor speed. At the same time a very close approach (within 0·5 per cent.) to the boiler requirements is claimed in the case of the stokers and secondary air fans which allow of trimming up to 50 and 30 per cent. respectively in order to meet changes in fire thickness. Independent speed adjustment of the induced draught fans, which

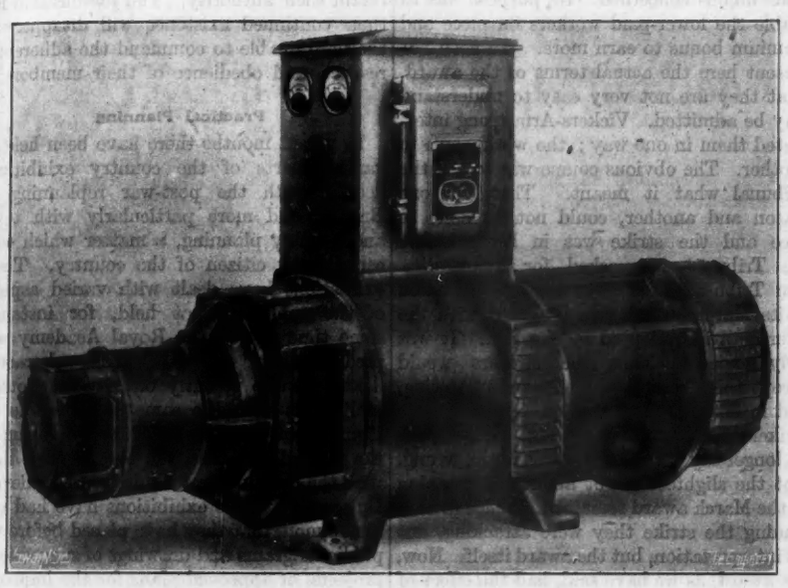


FIG. 3—COMBINED GENERATOR, EXCITER AND MOTOR

establish the common line of control, can be made by trimming up to 20 per cent. of reduced speed from the full revolutions per minute of the motors. All these secondary controls are of a semi-permanent nature, only required with change of fuel or boiler conditions, and are independent of the primary adjustment of load control.

With the momentum of the heavy fan impellers on the induced draught and forced draught fans the operation of reducing load sets up regenerative braking, which allows for quick shutting down in an emergency. Should the A.C. motor switch trip on overload the regenerated voltage maintains the correct relationship between the services in closing down. With no A.C. regeneration the braking is reduced, the boiler shuts down slowly, and it is possible for the fault to be rectified and the motor started before steam is lost on the boiler. In restarting, open contacts on the generator rheostat prevent the A.C. contactor starter being closed unless the control is in its lowest position. To prevent the main control being operated too quickly and the generator overloaded, a centre-zero ammeter indicates rising or falling loads and an alarm sounds for a set period before the A.C. motor starter trips out. An emergency push button is installed near the fans for tripping the A.C. motor in any emergency (Fig. 2).

COMBINED SUPPLY AND CONTROL UNIT

The service motors are supplied from a 500-volt D.C. generator and a 200-volt exciter, which are mounted in one housing with the squirrel-cage driving motor (Fig. 3). The generator field is mainly energised at constant voltage from the exciter, but voltage control is obtained by means of the shunt field rheostat operated by the load control hand wheel.

The control cubicle is mounted on top of the motor generator set and comprises four panels: a starting panel to the front, the main load control panel on the left side, the boiler trimming panel on the opposite side, and a connection panel at the rear. The starting and load control panels can be seen in Fig. 3.

The A.C. input to the motor generator set varies from 23 to 61 per cent. of the full rating over the usual operating range. This economy is mainly due to the control of the fans, whose power increases as the cube of the fan speed.

OPERATING RESULTS

The accompanying table, giving the results of some tests on a 60,000 lb. per hour boiler, indicates that such economy is in practice readily attainable and may even be improved upon. The low generator voltage was in this case due to good operating conditions and a new boiler with all passages perfectly clean. No trimming was necessary.

Test on 60,000 lb. Per Hour Boiler

Boiler load, lb. per hour... ...	35,000	60,000	67,000	71,000
General voltage (0–500 volts) ...	165	247	265	280
Hand wheel:				
General control...	50°	110°	118°	140°
Induced draught	180°	180°	180°	180°
Secondary air ...	240°	240°	240°	240°
Primary air ...	180°	180°	180°	180°
Fuel feed	180°	180°	180°	180°

The simple operation of the unified system of boiler control and the simple trimming of the auxiliary services, independently and from a centralised control station, is at once apparent. Moreover, the provision for preselective setting in anticipation of load changes and the fine adjustments with their rapid response account for substantial savings in boiler operation. Works engineers will appreciate, too, the substitution of a few hand wheel operated rheostats for the multiplicity of motor controllers, air dampers, and gears associated with the usual methods of boiler control.

SAILING BOATS IN SERVICE.—In order to effect fuel economy in Canada, old sailing boats are again in service in the Bay old Fundy, and nearby waters, for transporting logs, lumber, and pulpwood.

Scientific Research in Post-War Britain

WE reproduce below the official summary of a report prepared by a sub-committee of the Parliamentary and Scientific Committee entitled "Scientific Research and the Universities in Post-War Britain." The report has received the private and general approval of Professor Blackett, Professor A. V. Hill, and Lord Hankey.

If Britain is to maintain her position in the post-war world, and carry out her plans for reconstruction and social betterment, scientific research and the application of scientific knowledge should be promoted on a far bolder and more imaginative scale than in 1919–39. This applies equally to fundamental, industrial, agricultural, veterinary, and medical research. There should accordingly be proportional expansion of the supply of scientific personnel. This in turn calls for expansion at the universities, and technical colleges, and an all-round improvement in the teaching of science and scientific principles at all stages of education for the whole school population of the country. As a first step there should be an effective organisation of the demobilisation of the large number of scientific people now on war work or in the Services to enable them to complete their training and to guide them into positions where their previous training and their war experience will be of special value. It is hoped that this will be adequately covered by the Committees under Lord Hankey, but the maximum assistance will be required from Government and private enterprise. The universities should prepare for a rapid growth in the number of students of science and technology, and possibly ultimately to a doubling or trebling of their total. This will call for an expansion of existing universities, and possibly the development of some existing establishments into new universities. The wartime system of State bursaries and engineering cadetships should be continued and developed to cover sciences not hitherto included, and the recommendations of the Norwood Committee on this point generously implemented.

Materials and finance should be made available for the expansion of research schools in the universities. The number and value and scope of the post-graduate grants awarded by the D.S.I.R. also need to be considerably increased; more post-doctorial fellowships are also required. University staffs, stipends, and buildings should all be increased. A capital sum of £10,000,000 will be required for buildings and equipment spread over the first five post-war years, as well as adequate priority for the work and materials involved.

The present annual Treasury grant to the universities of approximately £2¼ millions per annum should be increased to £6 or £7 millions per annum.

The freedom, independence, and diversity of the universities should not be prejudiced in any circumstances, but to ensure the best use of the increased funds. To avoid wasteful overlapping they should set up a suitable Universities' Advisory Council. The recent assurance of the Government that they recognise the need for increasing the provision for technical education is most welcome, and it is hoped that this proposal for a revision and expansion of the £12,000,000 scheme of development mooted before the war will be put into effect without delay. The provision of adequate facilities for part-time technical study and training should also be increased. There is a need for greater assistance to promising young people already engaged in industry to enable them to take full or part-time courses.

Courses in "laboratory arts" should be instituted in order that there shall be an adequate supply of properly trained laboratory technicians, and young people should be encouraged by the provision of grants to enrol in such courses. The status and remuneration of laboratory technicians require improvement. The supply and training of technical teachers requires urgent investigation.

The Engineer

OCTOBER 8, 1943

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DEATH

On October 5th, at Wethersfield, Essex, Sir JAMES FORTESCUE FLANNERY, Bart., M. Inst. C.E., in his 92nd year.

THE BARROW STRIKE

THE anxiety which was felt when the nine thousand strikers at the Vickers-Armstrong Works, Barrow, refused to accept a ruling of the National Arbitration Tribunal was lessened, but not wholly removed, by the announcement on Tuesday last that the firm and the strikers had come to terms and that work was being resumed. There have been several strikes within the last few months, but not one of them has aroused such general interest as this; in not one has the public been so mystified, so baffled in its efforts to comprehend why a considerable body of men and women who are all loyal in spirit could withhold essential labour at this critical hour, jeopardise the very lives of their own relatives and friends, and delay the coming of victory. In mining strikes an element of sentimentality—often misplaced—almost always intervenes. In this case there is no circumstance that can warrant such emotions. The conditions of work are not in question. The only matter in dispute was the interpretation of an award affecting wages. There was no question even of inadequate payment. In these circumstances the public could not see any excuse for the withholding of labour and the dislocation of the operations of a great works engaged on the production of primary materials of war.

The dispute turned on the interpretation of an award made in March last by the National Arbitration Tribunal. That award was accepted by the representatives of the trade unions concerned. Its purpose was to enable the lower-paid workers on piece and premium bonus to earn more. We need not present here the actual terms of the award. That they are not very easy to understand may be admitted. Vickers-Armstrong interpreted them in one way; the workpeople in another. The obvious course was to ask the Tribunal what it meant. That, for one reason and another, could not be done at once and the strike was in being before the Tribunal was asked for its verdict. The Tribunal then gave an interpretation of its March award, which agreed with the interpretation adopted by the firm. It was fully expected that the strikers would accept this decision, but at a mass meeting, and in defiance of their own executives, the strikers decided to remain out. They could no longer say that the firm was in the wrong. Not the slightest doubt about the meaning of the March award remained. Hence in continuing the strike they were attacking, not its interpretation, but the award itself. Now, the award, as we have said, had the effect of raising the wages of the lower-paid workers more rapidly than the wages of the higher-paid. That, we believe, is the root cause of all the trouble. The higher-paid men do not wish to see the lower-paid brought into nearer equality with them. They welcome higher wages for the lower ranks, but only on condition that their own wages are raised at the same time.

But the cause of the strike is of far less consequence than the strike itself. From first to last it was unconstitutional. It was a rebellion against an endorsed agreement and was not sanctioned by the unions. Mr. Bevin said a few days ago, after the mass meeting of the strikers had decided to continue the struggle: "The matter which was in dispute has now been settled beyond doubt and the decision of the Tribunal is final and binding. The workers who are on strike are deliberately flouting their own agreements and the arbitration procedure to which, through their union, they are parties. . . . The only honourable and proper course for the Barrow workpeople is to accept the decision of the Tribunal and end this matter." That was clear speaking. But unfortunately the matter does not end there. Nearly all, if not all, the strikes that have occurred in the past few months have been unconstitutional and against the advice of the trade union leaders. The sense of responsibility and discipline is disappearing. At any moment another strike may break out. Mr. Bevin has asserted that "the Government are determined to support constitutional methods of settlement of industrial questions, and the success of these methods is dependent upon the maintenance of the trade unions." Unless the Government can devise means of supporting constitutional methods and enforcing observance of them if necessary, the whole trade union organisation will be threatened, and further outbreaks must be feared now and even more hereafter when the restraining influence of the war is removed. Firm and determined action by the Government and the unions is called for. All the machinery for maintaining industrial peace is put in jeopardy by unconstitutional and unsanctioned strikes. The first responsibility lies upon the unions. They must put their houses in order; they must regain and retain their authority. The justification for their continued existence will disappear if they are unable to command the adherence, respect, and obedience of their members.

Practical Planning

IN recent months there have been held in various parts of the country exhibitions dealing with the post-war replanning of Britain, and more particularly with town and country planning, a matter which concerns every citizen of the country. These exhibitions have dealt with varied aspects of the subject. That held, for instance, some time ago at the Royal Academy was predominantly architectural in character. Another more recently on view at County Hall dealt with the same subject—the replanning of London—with more relation to the ground plan and the organisation than with the architectural results to be achieved. But most of these exhibitions have had this in common, that they have placed before the public diagrams and drawings of suggestions, projects, or approved plans for the improvement of actual neighbourhoods. The "Practical Planning" Exhibition, opened last Wednesday at the Institution of Civil Engineers and arranged by that Institution in collaboration with the Institution of Municipal and County Engineers, has been designed with a different intention. It does not deal so much with actual plans—though some plans, diagrams, and models of actual projects will be found there—as with all those multifarious factors that must be considered in drawing up a plan and preparing it for execution.

The new Exhibition is designed to show, firstly, how plans, however local, need to be drawn up in relation to regional and national requirements; and secondly, to demonstrate that on the basis of a plan so drawn up the engineer must get to work on the design of those less obvious things, such as supply mains for electricity, gas, and water, road and rail connections, extensions or alterations to power-houses, gasworks, sewage works, and many other matters, all of which the public is inclined to take rather for granted, although the ultimate health, prosperity, and comfort of the future community will depend upon them. It is this aspect of the Exhibition that will, we think, particularly interest engineers. For, since the Exhibition has been designed to appeal especially to the general public,

it is not of so much interest to the technician. Yet because it serves to bring out in a rather remarkable way that fact of which all engineers are aware, that our civilisation to-day has been built upon and is dependent for its continuation upon the practical work of engineers, it is an Exhibition that all engineers should make a point of visiting.

In thus referring to the Exhibition as one predominantly concerned with the work of engineers, we do not wish, nor, we are sure, do the two Institutions concerned wish, to belittle the share of architects in the work of planning. A really satisfactory result cannot be achieved, as Mr. W. S. Morrison, Minister of Town and Country Planning, pointed out in opening the Exhibition, without the warm co-operation in the task of engineer, architect, and surveyor. But whereas much of the work that is put into a project by the architect stands as a monument before the public for all to see, the contributions of the engineer often function unseen and unsung. Moreover, the public, uninstructed technically, is only too naturally apt to assume that the existence of a model, a plan, or a diagram of a project is in itself proof that the project is ready at a moment's notice to be put out to contract. In fact, as all civil and municipal engineers are aware, anything up to eighteen months may elapse, according to the scale of the work, before all the detailed designing and the drawing up of bills of quantities, &c., can be completed and a true picture of the work to be undertaken be put before contractors who wish to tender. If the Exhibition but serves to bring home to a sufficient leavening of the lay public the debt that is already due from the community to engineers, the complexity and wide scope of the practical work undertaken by them, and the consequent necessity to provide the staff and the time to work out fully all the details of a new plan, it will not have been held in vain.

"Practical Planning" Exhibition

LAST Tuesday, October 5th, there was opened at the Institution of Civil Engineers, Great George Street, Westminster, the "Practical Planning" Exhibition. This Exhibition has been arranged by the Institutions of Civil and of Municipal and County Engineers, and is open to the general public, for whom, indeed, rather than particularly for engineers, it has been designed. At the opening ceremony, Mr. W. S. Morrison, Minister of Town and Country Planning, was introduced by Sir John Thornycroft, President of the Institution of Civil Engineers, and Mr. L. St. G. Wilkinson, President of the Institution of Municipal and County Engineers, to a distinguished gathering of engineers. Mr. Morrison, after referring gracefully to the histories of the two Institutions that collaborated in preparing the Exhibition, remarked that the Institution of Civil Engineers was by that act modifying its tradition of austere reticence and employing the arts of publicity to further its aims. The Exhibition that he was to open illustrated both the wide variety of the engineer's services to the community and his increasing specialisation. Many of his services to the community could only be satisfactorily illustrated by such an Exhibition. It demonstrated how much hard thinking and calculation were necessary in planning and showed much that ordinarily lay behind the scenes. Mr. Morrison also referred to the relations that existed between civil engineers and the other members of the planning "team." It was clearly necessary that architects and engineers and surveyors should work as a team and he appealed for active partnership between them.

The Exhibition will be open to the public every weekday from 10 a.m. until 6 p.m. until October 30th. Conferences dealing with aspects of the subject of planning are to be held in connection with it every Wednesday afternoon of the month. The first, held last Wednesday, had as its subject "The Respective Parts to be Played by the Engineer, the Architect, and the Surveyor in Town and Country Planning," and will be reported in our next issue. Details of the other conferences will be found in our Forthcoming Engagements column on page 296. It is intended also to bring parties of engineers and others from various parts of the country to visit the Exhibition, and older school children from the various districts of London will have the opportunity to see it.

The "Practical Planning" Exhibition is the first full-scale exhibition to be held at the Institution of Civil Engineers, although at the yearly conversazione in peacetime a number of individual engineering exhibits used to be shown. The object of the present Exhibition is to show how the best use can be made of the supplies of money and material which will be available after the war.

Practical planning, it is intended to show, will ensure that there is a logical sequence in planning; adequate attention is paid to physical and economic factors, as well as to æsthetic considerations; there is co-operation between the engineer and all interests concerned from the start; and full use is made of the help which engineering science can give in the development of Britain.

The Exhibition illustrates some of the many ways in which modern civilisation is dependent on the work of the engineer and indicates problems which still require solution. It opens with an extract from Mr. Arthur Greenwood's speech in the House of Commons in May, 1941, which exemplifies the aim of practical planning. The basic factors of centres of population, ports, and location of mineral deposits, and the effects of the war on planning problems are illustrated. The necessity for national planning in connection with a number of subjects is stated and the importance of regional planning before local planning is undertaken to ensure co-ordination and economy. As an example, work in the county of Warwick is illustrated by a model of Warwick and plans.

In the development of existing towns co-operation between the engineer and all interests concerned will be required, together with an appreciation of physical and economic factors as well as of æsthetic values. A logical sequence would need a civic survey, a skeleton plan for the whole area, and detailed plans for particular areas. Plans showing age of property, surface utilisation, communications, and open spaces are used to illustrate the point. Birmingham is taken as an example of the development of an existing town, and plans showing the general planning of Birmingham and the more detailed planning of one area, Duddeston (with a model), are presented. Similarly, a model and plans of Wakefield are included. Some examples of approved plans under the Act of 1932 (Coventry, Stafford, Shrewsbury) are shown with photographs of the reconstruction of the English Bridge, Shrewsbury, to illustrate how the old appearance has been retained by the use of the old stones and additional stones from the same quarry. Examples of the work of local government engineers are illustrated by plans, diagrams, and models of housing estates, many types of civic and other buildings, swimming baths, health centres, &c. As examples of practical planning there are included illustrations of the use of a low-lying refuse dump for pleasure grounds, the reclamation of foreshore for a promenade, the covering over of rivers in cities for civic centres, river training, &c. The principles to be followed in the planning of a new town are brought out, and what has already been done in trading estates and garden cities is illustrated by a model of Team Valley, and plans of Wythenshawe, Welwyn Garden City, and a green belt town.

The importance within the framework of a practical plan of the co-ordination of traffic and of providing for the growth of air transport is not neglected and is illustrated pictorially, by models, &c. Maps are shown of Roman roads, trunk roads, and the 1000 miles of motorways proposed by the County Surveyors' Society. Types of roundabouts, clover-leaf crossings, T junctions, &c., are illustrated, and the fact that there is no one general solution for all road problems is brought out, so that it is clear that each problem has to be solved in accordance with its particular circumstances.

The development of the public supply of electricity from the small 40-kW set of 1882 in Hastings to the pre-war 100,000-kW set is shown by a set of photographs. It is made clear that more efficient generation due to an increase in thermal efficiency has been responsible for decreased costs and increased use of electricity. Among problems that will have to be tackled after the war, it is suggested, are the speeding up of the standardisation of voltages, of equipment, and of methods of supply and a reduction in the number of supply authorities.

The important part that the gas industry plays in the supply of many of the present-day necessities through the by-products of coal processing are illustrated, as well as the part it plays in the reduction of atmospheric pollution.

An exhibit of more direct interest to the technically minded illustrates the possibilities of district heating, and it is pointed out that it can be provided by installing centrally placed boiler-houses for generating steam or hot water, or by utilising exhaust steam from steam turbines generating electricity. An example of the central supply of steam and hot water on efficient lines is illustrated by a plan and model of the Treforest Trading Estate, as well as a suggested scheme for the introduction of district heating in areas of Coventry that are to be reconstructed.

Sources of water supply are pictorially illustrated. The increasing demands due to higher standards of housing are shown by figures of the supply of water in London daily in 1904–5, 1938–39, and estimates for 1956–57. It is pointed out that the supplies of water are not unlimited, but that by proper allocation and the avoidance of waste, resources should be adequate. The necessity for more comprehensive records of supplies, both in quantity and quality, is stressed, as

well as the desirability of the regionalisation of water supplies. A model of an up-to-date pumping works is shown.

A series of exhibits shows the improvement of methods of sewage disposal through the sewage farm, contact beds, percolating filters and activated sludge, and the arguments for the regionalisation of sewage disposal are stressed. An example of an up-to-date activated sludge plant is illustrated and shows how this one plant replaces twenty-eight smaller works, occupying an area of land of 1000 acres, and at the same time produces valuable by-products in the way of fertiliser and methane gas.

The advantages of regional administration of a river and its watershed are stated, and the work that is proposed in the Bristol area is illustrated by maps and diagrams.

All these exhibits illustrate how essential it is to a satisfactory result that there should be planning ahead and show how very much preliminary work must be done before the man can get on to the job. The moral is thus pointed that if it is intended that reconstruction should start immediately after the war, then the services of technical staff must be made available in time.

The last sections of the Exhibition deal with the work undertaken by engineers within buildings themselves. First, the structure of a building, its foundations, framework, and facade are illustrated. Then panels, models, and other exhibits illustrate such matters as heat conservation by the treatment of walls and roofs and the lagging of pipes; alternative constructional materials to those in more general usage; and the uses of plastics in buildings. The effect of a method of sound insulation for rooms by the use of glass silk is demonstrated by a working model. Women visitors to the Exhibition will be interested in a full-size model of a kitchen, together with typical electric and gas appliances that might be used in such a kitchen.

The Exhibition was organised by a Joint Committee of the two Institutions, with Mr. W. T. Halcrow, Member of Council, Institution of Civil Engineers, as Chairman, supported by Mr. L. St. G. Wilkinson, President, Institution of Municipal and County Engineers. The whole Exhibition was organised and carried out in five months under wartime conditions, as it was felt that it was very important that the problems illustrated should be brought to the notice of all concerned now that post-war planning was actively under consideration.

Mr. A. Hulme Chadwick, of the Design Group, was responsible for the design of the Exhibition, and the Exhibition Division of the Lonsdale Hands Company was responsible for carrying out the work.

Outworking and Production

ALTHOUGH it is agreed that the most efficient place to manufacture machinery and its parts is in a factory, outworking in the engineering and electrical industries has become important in the last two years. By its adoption many people who, through age, domestic ties, and other obligations, may be prevented from working in a factory, are given an opportunity to utilise their services for wartime production. We are informed that the latest figures show that there are some 20,000 outworkers in Great Britain at the present time and that the number is rapidly growing. It is interesting to record that, although progress has been reported from all over the country, at present nearly half the outworkers are in the London Regional Area. With the object of showing what has been done in typical instances, the Ministry of Production, in collaboration with the Ministries of Supply and Aircraft Production, recently arranged a visit to representative outworking centres in and near London.

The first centre inspected was one in which a unit of non-directable labour was assisting the Army Ordnance Corps by packing Army spare parts into small cartons and repacking these in larger cartons, thus forming a self-contained unit of spare parts. It has been found by the Army Council that with the change in conditions of warfare and with the extended use of landing craft much smaller units of spare parts for guns and vehicles can be profitably employed until the Ordnance Stores are able to make contact with the advance units. A special report on the packing of spares has been prepared by Major Starley, and in future the packing of them in appropriate carton form will probably have to be undertaken by all firms which are supplying Royal Army Ordnance Depôts with spare parts. The work at the present time is being done by the Army Ordnance Depôts themselves, and the unit we visited was formed as a result of an inquiry made by General Williams, and is typical of those which are to be set up in order to release personnel working in the depôts for other military duties. The work is being carried on not far from London in a ground floor store with a side entrance for road transport, and a large upper room has been rented. The boxes of spare parts, containing such items as bolts and nuts, setscrews, washers (metal and felt), gear lever knobs, &c., are stored below and are carried up into the packing room as required. Two or more roller feeding tables are used between the working tables, and more than 100 women and girls are employed in two shifts each of 4½ hours. By this means part-time labour can be used. The work consists of sorting the items, packing them into cartons and affixing labels, which are painted with moisture-proof varnish. Road transport brings in the cases of spares and removes the packed cartons to the depôt, where they are inspected before going to stores or being dispatched to units. Factory conditions are observed and a rate of 1s. 3d. per hour is paid. Only a small amount of supervisory labour is required.

Quite a different type of work was being carried out at the next place visited. It was at a branch of a firm of retail house furnishers, with twenty branches scattered over the Home Counties. The retail furnishing trade before the war represented a capital interest of about £125,000,000, much of which was immediately rendered idle by the stopping of the manufacture of furniture. From the beginning of the war the firm was anxious to help in the war effort, more particularly as many of its branches are situated in districts without industry with pockets of untapped labour. The first outworking unit was begun in September, 1942, at one branch, where a corner of one of the showrooms was dismantled and twelve part-time immobile volunteers began work on the preparation of cables and Brize connections for the wiring of "Halifax" and "Lancaster" bombers. A contract was obtained and by the end of January, 1943, a training school had been set up on the premises under the guidance of the contractor, and nearly 200 local housewives regularly attended and were employed on the cutting, stripping, tinning, binding, panning, and inspecting of twenty-nine to thirty different types of connections which are essential to this particular system of electrical wiring. In December, 1942, it was decided to open a unit at another branch, and one of the showroom floors was dismantled and machines and equipment installed for the work of armature coil winding. This work is carried out in co-operation with the contractors, and is in connection with several forms of small generating units used in aircraft and tank work. Three of the volunteers, who were recruited by an advertisement in the local paper, were sent to the contractor's factory to learn the more technical aspects of the work.

At the present time about 300 workers are employed in this unit alone. The hours worked are in two shifts from 8 a.m. to 1 p.m. and from 1.45 p.m. until 6.15 p.m. Within fourteen days the work was started and a preliminary target set. Absenteeism is extremely low considering the fact that most of the women and girls have domestic duties to perform, and does not exceed 7·3 per cent. A further unit was started at another branch, a further showroom being adapted for coil winding. These centres are run under factory conditions, the appropriate trade union rates being paid. They form a particularly good example of the close co-operation between a contracting firm and the outworking units.

In a Journal note of March 5th we described a plan for the development of decentralised part-time workshops, which are utilising effectively women's part-time labour in order to assist factories needing help in hand finishing of component parts, which often form a bottleneck in production. This scheme was started nearly a year ago by Mrs. Sydney Gampell. During our recent tour we visited the prototype shop which was established in Mrs. Gampell's own lounge. Two kinds of work were being done, first, the hand finishing of frames for goggles used by transport tank drivers and air pilots, which from the component parts were stitched ready for the insertion of the lenses at the factory. This is done in private homes. Secondly, the ends of intercommunication cords were being stripped, bound, and tinned. The lengths of cable as received from the factory are cut to length, the lengths of the ends differing, after which they are bound and, when necessary, tinned. Many thousands of these cords have been completed, and a steady and increasing flow of work is maintained. Other centres connected with this scheme have already been started and at the centre we visited upwards of seventy women are employed.

A very different kind of work was being done at another War Work Centre, which was started and is being run by a Rotary Club. The work, which was begun in August last, consists in assembling and testing small carbon filament lamps for gun sights. They are employed on naval work. The brass sockets or caps are cleaned and the lamp terminals threaded through them, after which the lamp is fixed into position with plaster of paris. Surplus plaster is then trimmed off, after which the ends of the lamp leads are clipped

and the lamps dried in an oven. They are then soldered and tested on a 24-volt circuit by means of a small transformer. After finally trimming and polishing the shanks are marked with an acid stamp, after which the lamps are packed for dispatch. This work is being done in collaboration with a well-known electric company, and up to the present thousands of lamps have been turned out to the satisfaction of the contractors. Two shifts are worked from 8.30 a.m. to 12.30 p.m. and from 1.30 p.m. to 5.30 p.m. One of London's busiest fire stations was then visited. During spare time and leave members of the National Fire Service were assembling air filters, which are used in connection with power tyre pumps on motor transport vehicles. At another fire station the pumps themselves are being assembled. The main body of the filter is assembled on long tables with simple hand-operated gears for screwing in the plugs and connections and the pressure gauge. The internal part of the filter is prepared by girls from the control room, who also assemble the dust caps with their attaching chain. A water and oil-tight joint between the filter element and the body is made with gold size. Well over a thousand filters are being turned out each week. Many fire stations are finding congenial employment on a variety of work which includes electrical assembly work, such as radio sets and simple apparatus. Other work includes fettling castings and deburring components. The whole of the work is under the control of a senior company officer operating from Regional Fire Headquarters, with district officers for different parts of London and the outlying districts. The system of payment is of interest. Five per cent. of the money received is deducted for N.F.S. services, after which half is paid to the Treasury and the other half goes to various charities and benefits connected with the station staffs. The work is much enjoyed by the men and women, some of whom have acquired considerable manual dexterity. The workers are keen, and it is considered that this part-time work has had a good effect in making them more fit to carry out their fire services.

Another visit, the last one to be paid, was made to a works in the London area, where some fifty-five women refugees are engaged on the assembly and testing of milliammeters and millivoltmeters. A parent firm, makers of electrical instruments, finding it impossible to obtain further labour locally, decided to form outworking units in residential districts where the assembly of electrical instruments could be put out to local labour. The first unit was confined to the simple assembly of the bridge for electrical measuring instruments. As time went on more advanced work was introduced, and to-day workers with but little technical training are assembling, testing, and sealing these small and very accurate electrical measuring instruments. The firm now has no less than eleven outworking units in operation and is putting out the complete assembly from its main factory and also from a subsidiary company. One firm which we visited may be congratulated on the quick and complete assembly of voltmeters and ammeters with refugee labour, which previously had been looked upon as a very skilled trade.

Enough has been said to indicate the wide scope of work which can be done on the outworking system. In order to interest firms in this work, the Ministry of Production has prepared and issued an outline of the various types of work and the control, inspection, and payment of outworkers. This brochure has been prepared by the Ministry of Production in conjunction with the Ministry of Supply and the Ministry of Labour and National Service, and can be obtained from the Ministry of Production Regional Offices, which are prepared to advise firms on outworking problems.

The Barrow Strike

(By an Official Spokesman of the Engineering Employers' Federation)

The straight questions at issue after Barrow are :—

(*a*) Have the workpeople got what they were striking for ; and

(*b*) Have they got anything they could not have got without striking ?

What they struck for, against the advice of their own unions, was to enforce an interpretation of the March Tribunal award, which was contrary to the interpretation generally accepted throughout the rest of the country by employers and workpeople alike.

It is now known that the workpeople were badly advised regarding the meaning of the award by parties outside their own unions.

The generally accepted interpretation, which was abundantly confirmed by the Tribunal last week, was that basis times required an adjustment in order to carry out the intention of the award.

It was, however, obviously impossible to discuss what adjustments might be appropriate to local conditions at Barrow while the workpeople were denying that any adjustment at all should be made under the award.

The result of the illegal strike has been to prove the strikers wrong in their contention. Thus they have not obtained what they were striking for.

Having confirmed this fundamental point of principle, the way was then open for the firm to discuss with the recognised trade union officials the exact details of the adjustment required by local conditions.

It must, however, be made clear that this could easily have been taken care of through the normal negotiating machinery without any stoppage of work.

Many figures have been quoted as to the meaning of the settlement. For most of these which have emanated from unofficial quarters there is no justification.

It would be unfair to allow loyal workpeople in other parts of the country to think that by an illegal strike workpeople at Barrow had gained anything more than would have been obtained through the regular machinery.

Included in the terms of settlement are a number of other minor items which were not strictly a part of the main issue involved in the strike, but were as a matter of convenience dealt with at this time. These likewise were all matters for which the regular negotiating machinery was always available.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

WHAT IS "WORK" ?

Sir,—Many thanks for your discussion on "work" in your issue of September 24th. I had always regarded work and pleasure as being distinct opposites, but after reading your article I was doubtful, and a subsequent visit to the dentist persuaded me that perhaps "pain" is the opposite from pleasure.

After all, while it is possible to experience two emotions at once, on the face of it work and pleasure do truly seem strange bedfellows.

Again, would not work be broadly defined as "the exercising of the will power against one's own inclination" ? Is it not sometimes hard work to refrain from doing something which we want to do ?

Perhaps we could say that work and pleasure is almost as strange a mixture as free agency and destiny, which, I think, controls our actions.

H. Beck.

Studley Road, Redditch, Worcs,
October 4th.

Sir,—Your article of September 24th, entitled "What is Work ?" suggests to me what a good thing it would be if you could give further consideration to the way in which work should be rewarded and the arguments in favour of payment by results.

A great many work well and are satisfied with a weekly or hourly reward for doing their best, while in the case of others it is assumed they will not give a good output unless they are paid in some way which takes into account what they do. Does that mean that some take pleasure in their work, whilst others have to be bribed to undertake it ? The amount of clerical work involved in recording and calculating their earnings absorbs a great deal of man power at the present time, and there are always arguments and quarrels.

Ford appreciated this when he ran his business without any scheme of piecework or bonus. The American shipbuilders, who have shown such wonderful results in the great majority of yards, work in the same way.

It would be interesting to know what proportion of manual workers in this country are on schemes of payment by results. Agricultural workers are not, but coal miners are.

Lord Perry, chairman of Ford Motor Company, Ltd., has said that, of the many thousand workers under his control, none are on P.B.R.,* and they do not even get an extra rate for overtime.

John.

London, October 4th.

"THIS FREEDOM"

Sir,—May I encroach once more upon the hospitality of your columns to express my sincere thanks for the courtesy with which Mr. L. Lindsay tenders his appreciation of my country's art of putting freedom into practice (The Engineer of October 1st) ? That freedom is exactly the outcome of the Swiss people's ability to think and act collectively. Their love of freedom made them realise early on that this very freedom can only be secured and maintained by collective thinking and acting. That is why the Swiss are all convinced Republicans, and why they subscribe enthusiastically to the referendum. They are politically sufficiently mature to exercise individually the right to tell the Government collectively that the law of the country must be so and so. Mr. Lindsay's recognition of the high standard of Swiss engineering products also constitutes pleasant reading. May I say here that in Switzerland the progressive freedom and engineering inventiveness of England are both greatly admired ?

By all means let engineers, for instance, enjoy absolute freedom to invent, to create—so admirably advocated in the leader in The Engineer of September 10th—but let the outcome of their endeavours be more freely put at the disposal of the masses collectively. In our time, I venture to suggest, we should not permit unheard-of, really excessive, fortunes

* Payment by results.

to be piled up individually; allow the result of collective labour to reach the people collectively, directly, and, apart from taxes, not merely by more or less debasing charity—a happy medium might be struck; let the creative mind benefit reasonably at the hand of its genius, and see to it that the people who helped the invention to reach a state of actual production benefit, too, individually and collectively. Switzerland is, I am glad to say, making and always has been making good progress on this road, so much so that communism, for instance, can be termed there an avoidable and unnecessary malady, doctored by the collective action of the people.

The freedom of my country's people began to crystallise when in 58 B.C. Orgetorix the Chieftain aspired to become King. The Helvetii decided collectively to remain free and ever since, through all the vicissitudes of time, they have remained so, and intend to remain so collectively. Progress knows no bounds. The Swiss individually and collectively labour insistently, as for the matter of that the English do, to make the "bread-basket" more accessible to all. G. Wuthrich.

London, W.C.1,
October 4th.

HYDROGEN IN BOILERS

Sir,—In drawing upon his memory for his address entitled "Experience Teaches" (*vide* The Engineer, September 17th), Engineer Vice-Admiral Sir George Preece referred to a peculiar incident in which flames were emitted from an air pump breather. The explanation given, *i.e.*, that hydrogen had been generated in an overheated boiler, is not convincing.

It is true that hydrogen can be generated by passing a current of steam over red hot iron or steel turnings, but note the conditions—a large surface area of red hot metal must be exposed to a current of steam. It is difficult to believe that any boiler could continue to produce steam if the heating surfaces attained such a temperature or, indeed, that such temperature could be attained if the surfaces were swept by a current of steam. In support of this contention the modern superheater may be cited; if its heating surfaces were not continuously cooled by the steam passing over them, its life would be very short and the steam would be heavily charged with hydrogen. E. B. Parker.

Wirral, Cheshire,
October 3rd.

Sixty Years Ago

The Foundering of the "Austral"

In our issue of October 12th, 1883, we published the judgment of the Wreck Commissioner—Mr. H. C. Rothery—on the foundering of the Orient liner "Austral," while being coaled in Sydney harbour on November 11th, 1882. The "Austral," built by Elders on the Clyde, was a new passenger and cargo ship and was on her second voyage when the mishap occurred. She had discharged her passengers and cargo, emptied her water tanks, and taken in about 1620 tons of coal. The coaling was being continued through ports on the starboard side. When an additional 120 tons had been taken in the ship heeled over to an extent—about 12 deg.—sufficient to allow water to enter the coaling ports and foundered with the loss of five lives. Coming closely after the capsizing of the "Daphne," the accident once again called forcible attention to the inadequate study of ship stability on the part of shipbuilders and shipowners. Mr. Francis Elgar calculated the stability curve of the "Austral" in various conditions of loading. For her condition at the time of the mishap he showed that at small angles of heel the righting moment increased very slowly and that 120 tons of coal in one of the bunkers uncompensated by a corresponding weight on the other side would be sufficient to heel the ship to the extent required to immerse the coaling ports. The Commissioner vigorously emphasised the necessity for a close study of stability by all concerned and for communicating the results of such study to the captains of ships.

The Late Mr. Sam Mavor's Bequest

In the course of a meeting of the Mining Institute of Scotland, which took place in Edinburgh on Saturday, October 2nd, the President, Mr. John Finlay, of Uddingston, announced that a substantial bequest has been made to the Institute by the late Mr. Sam Mavor, a former President. The Institute has been informed that it was Mr. Mavor's wish, subject to a life rent, and to provision of certain annuities, to bequeath to the Institute ten parts out of one hundred parts of his estate, which money was to be used for bursaries or prizes to student members of the Institute in order to allow them to visit places, works, or mines of special interest to them. It was further laid down that the conditions in connection with the operation of the bequest were to be determined by the President and Council of the Mining Institute of Scotland, and that Mr. Mavor had expressed a desire that his name should be associated with the gift. Mr. Finlay said that the sum which would be available to the Institute would in due course be considerable. The bequest bore further testimony to the keen interest which the late Mr. Sam Mavor had always taken in mining education generally. The fund would, he thought, go a long way towards helping mining students with their future careers. The meeting agreed that Mr. J. B. Mavor should be invited to become one of the trustees for the administration of the fund by the Institute.

American Engineering News

Oil Engine Locomotives

While the oil engine locomotive on American railways has but a few years of history behind it, its design has been very largely standardised for the two main services of train operation and yard switching or shunting, this last applying to both railways and industrial plants. It has become a very satisfactory tool under war conditions. A present problem of the railways is to obtain sufficient motive power equipment to handle the ever-increasing ton-miles of traffic offered, so that all available power must be used, regardless of comparative economy. For switching service, the oil engine locomotive is easier to operate than the steam machine, and it can give continuous service for a longer period. For passenger train service, it lends itself readily to high-speed traffic on long-distance runs. For freight train service, it presents a standardised design applicable to all varieties of gradients. Further improvement will be made from time to time, and the experience gained for the design, development, operation, and maintenance of these machines under intensive war conditions is likely to result in a new era for their service after the war. At one plant specialising in such locomotives of various design, the output was increased considerably by concentrating on a standard design of 120-ton switching engine of 1000 H.P. The New York Central Railroad has specialised in the use of 110-ton engines of 600 H.P., and at its Buffalo marshalling yard twenty-nine of these engines have replaced forty steam switching engines. Where weight must be restricted, a 70-ton design of 380 H.P. is used. This one railway has about 145 oil engine switching locomotives, besides a few passenger train engines of 4000 H.P. serving the terminal system at New York. Standard sizes in mass production for industrial plants range from 25-ton machines of 150 H.P. to 80-ton machines of 500 H.P. High-speed locomotives for passenger train service are not now being built, but they have proved their reliability and economy, and will no doubt be increased for post-war transportation.

Fuel for Boiler Furnaces

Conversion of boiler furnaces from oil to coal fuel is still in progress in the United States, and different methods of conversion were discussed at a recent meeting of the American Soicety of Mechanical Engineers. It appears that some 48 million barrels of the annual oil consumption have been saved by conversions already made or in progress, with an additional 23 million barrels due to be saved by conversions planned but not yet carried out. With fuel oil demands increasing for increased production at present plants, the enlargement of plants and the tremendous military consumption, there is need of greater oil production and better transportation facilities for oil distribution. Some oil-fired furnaces can be converted to pulverised coal without great difficulty, but with a decided reduction of boiler capacity, since pulverised coal firing requires more water-cooling surface than does oil firing. The amount of such additional surface depends upon the method of firing and the quality of the coal. An alternative is the recirculation of flue gases to maintain normal or original capacity. Where limited space precludes the installation of direct firing pulverised coal equipment, there is an alternative in the direct-fired circulating system. In this the piping forms a loop from which the coal and air mixture is tapped off at each furnace as needed. That part which passes the last furnace is returned to the base of the pulveriser. The type of mechanical stoker for coal fuel depends largely on the nature of the coal, including its moisture content, volatile content, ash quantity and quality, coking properties, and sizing. Coal with high-quality ash is suitable for all kinds of stokers, but that with low-quality ash can be handled best by travelling grate and spreader types of stokers. Underfeed stokers can handle coals that coke in the fuel bed. Single-retort stokers of this type fire boilers up to a steaming capacity of 50,000 lb. per hour. Larger installations can be served by multiple-retort underfeed stokers.

Stock Pile Reserves

While numerous individuals and associations have been, and are, considering various plans for the post-war peace period, the American Institute of Mining and Metallurgical Engineers had at its annual meeting a paper on the stocking of ores, minerals, and metals in preparation for the next war. Taking as an example the vast quantity of iron ore needed for the emergency production of iron and steel with great rapidity, it was shown that the United States benefited greatly by the delays of the Axis forces, but that in another war immediate attack might allow no time for the mining, transportation, stocking, and processing of the ore to produce materials for defence or attack. To provide available necessary supplies of metals and ores for such a future contingency, and thus ensure against possible disaster, the plan suggested included the following points:—(1) Adequate Government-owned stock piles of war material should be provided; (2) the supply should be sufficient for whatever term of years might be found advisable by study of the problem; (3) the stock piles should be located near manufacturing centres, with due regard to strategic contingencies; (4) all war materials that can be stock-piled cheaply and without deterioration should be considered; (5) minerals should include ores of manganese, aluminium, tin, chromium, tungsten, vanadium, and others of new development or of which approaching shortage is evident; (6) certain partly manufactured materials should be included, such as pig iron, ferro-manganese, and spiegeleisen, also metallic aluminium, copper, nickel, lead, and zinc, as well as surplus scrap of these and other metals; (7) stock piles to be accumulated in periods of slack industrial demand and consequent low prices; (8) the Government authority set up to accumulate the stock piles should have no power to sell or dispose of these materials, except when authorised by the Congress in the event of a war emergency.

Grain-Drying Silos

FIFTEEN grain-drying silos are in course of erection in various parts of Britain. According to the Ministry of Works, a number of them will be ready to take in this season's harvest, and the remainder will be completed next year. Their erection is necessitated by the increased production and use of home-grown grain, which, having a higher moisture content than imported grain, has to be dried in bulk before milling or long-term storage can take place.

Movement by gravity and cheap storage facilities are the governing factors in silo design. Height is the dominant feature. There is a central working tower, brick built, with two reinforced concrete wings (with a brick-built pent-house), each of which contains a nest of twelve storage bins. In designing the buildings, drying facilities were of primary importance. While sufficient storage had to be provided to meet the deliveries of the local wheat growers, it had to be possible to interchange wheat from any bin to any other bin, either direct or *vid* the drying plant in the central working house, or to deliver it to road, rail, or river craft. The data given as a basis of design were:—Total intake from road and rail, 40 tons per hour; drying capacity, from 22 to 16 per cent. at 10 tons per hour; total storage capacity 5000 tons; capacity of each bin to be approximately 200 tons, to allow at least one bin to be turned within twenty-four hours; railway facilities for a twenty-truck loading-out capacity.

The wartime need to concentrate labour for supervision purposes resulted in the adoption of the central working house plan (Fig. 1), in which intake, trying and sacking-off operations are kept within a comparatively small area and easily supervised with a minimum of staff. Conveyors run from the central tower over and under the storage bins. Flanking either side of the nests and tower and intake platforms there are sacking-off annexes to road and rail, a boiler house, and an office block. The machinery receives the grain at intake level at the specified rate, lifts it to the height required, feeds it on to the conveyors, and eventually deposits it in the bin. The circulation to the dryer is completed by accepting the grain on the underbin conveyor and lifting it to the required height for gravitation through the dryer.

Height in silo bins not only restricts the area of expensive foundations; it is a structural necessity governed by the column of mechanical plant housed in the central tower, resulting in a working house 85ft. high and about 30ft. square. Each wing is 75ft. high, including pent-house, and 90ft. long. There are also a number of ancillary buildings containing the boiler for the dryers, heater batteries, switch gear, and control offices.

Prior to building, a geological survey is taken of the sub-soil. The foundation has to bear a superimposed load of about 9000 tons over an area of 210ft. by 30ft., and with continuous shifting of the grain variable loading has to be met. If piles are necessary, the "hit-or-miss" method of driving is therefore discarded in favour of accurate preknowledge of conditions. Construction work is initially concentrated on the central working house (Fig. 4). It is brick built on a steel frame and consists of seven floors. With the completion of the raft and underground work (Fig. 2), heavy reinforced concrete under-bin walls are erected, and the whole is made water-tight with a tanking of asphalt (Fig. 3).

The casting of the bin walls is an intricate job, requiring accurate placing of the steel reinforcements, maintenance of the required consistency of concrete throughout the operation, plumbing of walls throughout the height of 65ft., and the completion of a weatherproof wall free from projecting ledges that would impede the flow of the grain. A tolerance of only 1in. in 65ft., or 1 in 780, out of perpendicular, can be accepted, but this allowance is seldom required.

Two methods of wall formwork have been adopted, creeping or leap-frog. With the creeping or moving form method, construction joints are avoided, and it is possible to obtain

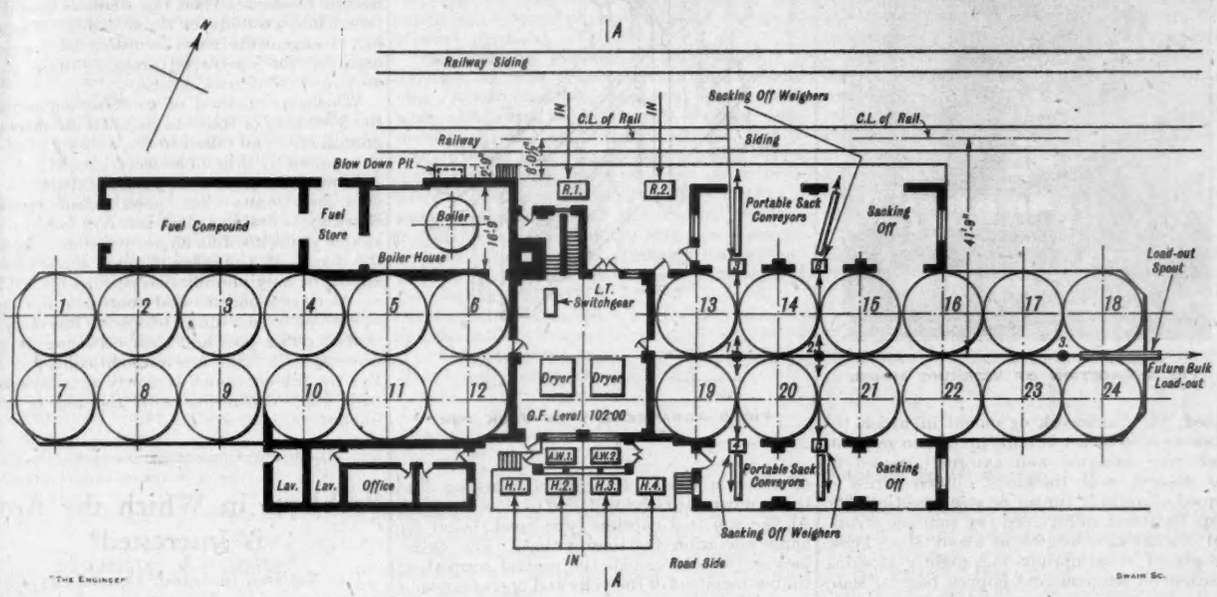

FIG. 1—PLAN OF GRAIN-DRYING SILO

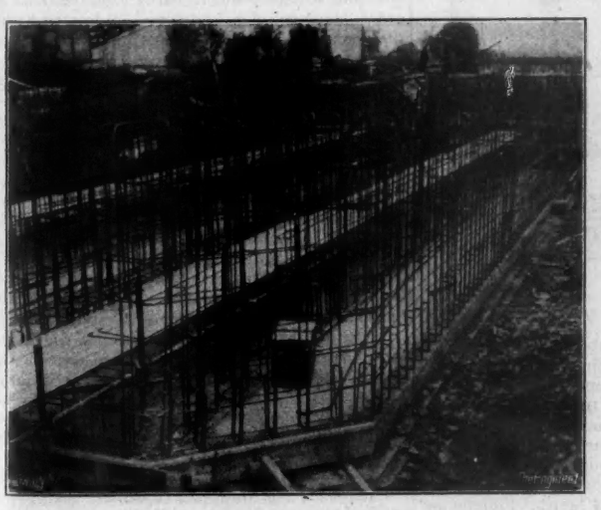

FIG. 2—FOUNDATION AND REINFORCEMENT FOR UNDERBIN WALLS

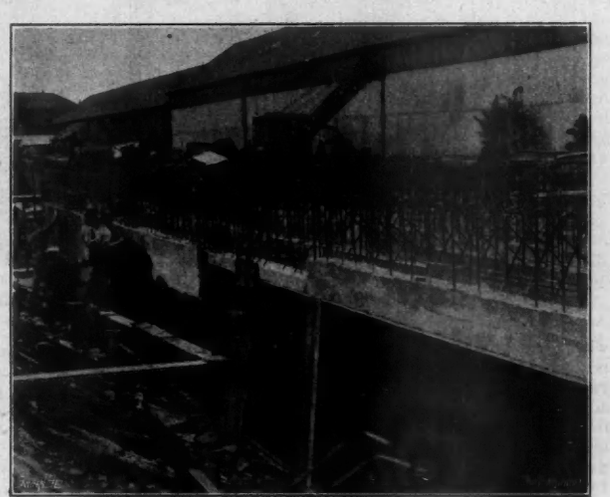

FIG. 3—WATERPROOFING UNDERBIN WALLS

a perfect wall over the whole height, whereas with the leap-frog method a construction joint is necessary with each lift. A further advantage with the creeping type is the speed of erection attained. A complete nest of bins with twelve units has been erected in six days—a rise per hour of nearly 5¼in. of a building 90ft. long, 30ft. wide, and 65ft. high.

After the underbin structure has been com-

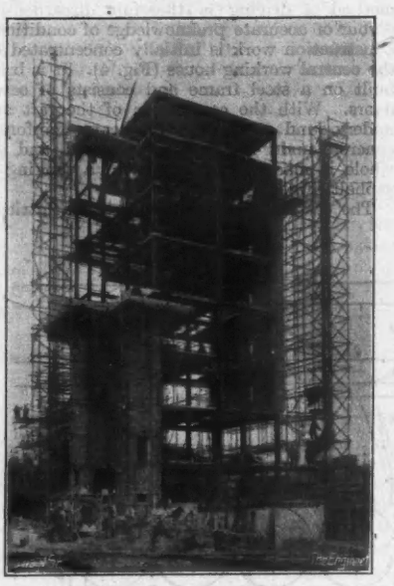

FIG. 4—ERECTION OF WORKING HOUSE

pleted, the framework or mould in which the concrete is to be set is built up of two series of shuttering (internal and external) spaced at the desired wall thickness. Each series is formed of units of timber or steel sheeting, 3ft. deep, battened and framed (by runners, struts, and blocks) into lengths of about 8ft. These are placed in an upright but slightly tapering position on the concrete hopper bottom slab,

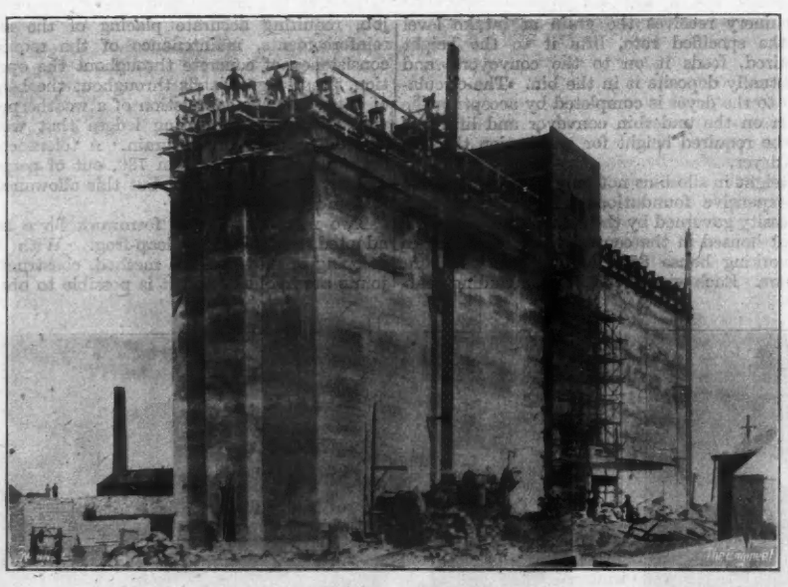

FIG. 5—SQUARE BIN SILO APPROACHING COMPLETION

with concrete guide blocks of finished wall thickness spaced at intervals along its length. The two series of shutters are tapered to reduce adhesion as much as possible and to allow the formwork flexible movement. The taper is arranged to give the required wall thickness, usually 6in., half-way up the shutter. The two sets of shutters are linked by means of a yoke (Fig. 6), or an inverted U frame, of heavy timber, with the legs securely attached to the runners forming the frame to the sheeting. Seventy-three yokes are required for each nest of twelve bins. The formwork is then tied and a working platform is fixed. The formwork is moved by means of jacks. To each yoke is attached a threaded tube of steel, at the bottom

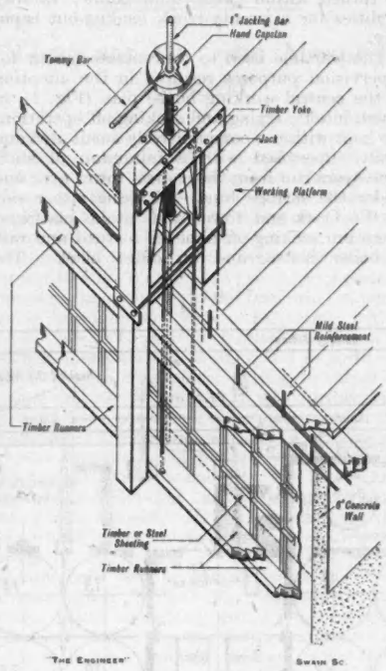

FIG. 6—ARRANGEMENT OF JACK FOR MOVING FORM

of which is a pair of spring jaws arranged so that a downward load will tend to close the jaws. At the top is a capstan type head, holed for hand operation by tommy bar. The entire jack is passed through the central supporting timber members of the yoke and operates over a 1in. mild steel reinforcing rod, firmly embedded in the concrete. It is on this steel rod jacking bar that the spring jaws operate, opening and closing with the necessary turn on the capstan.

About forty operatives are required on each nest of twelve bins. They are arranged in gangs and shifts, for when the pouring of the concrete begins, the work must proceed without interruption for a matter of 144 hours. Signals are of importance in the whole operation. As soon as the initial concrete is placed in position to the required depth, the shutter movement of formwork is begun by signal of whistle blast from the engineer in charge. Each given signal indicates the given number of turns required at any particular jack point. It is essential that the platform should rise true and level, and only by giving the correct number of turns to the jack capstan on each signal can this be achieved. A quick but accurate levelling is taken at regular intervals to a set point marked by a white painted board attached to each yoke. Independent check levels are also made, while chocks are provided to each capstan to avoid giving more than a quarter turn.

In the leap-frog method the formwork is similar to that used on the creeping type, but instead of being yoked it is clamped along the top edge. The forms are not tapered, but parallel. The concrete is poured and only when the section has reached the required set are the clamps released. Then the whole formwork is raised into position for the next lift. The lifting arrangements vary according to the plant used by the contractor, ranging from block and tackle to derrick cranes.

Whichever method of construction is used, the 2000 tons of concrete required are mixed at ground level and raised to the working platform as required by skip on an electric hoist.

In wartime the necessity for working throughout the twenty-four hours when creeping shuttering is taking place involves lighting and labour problems difficult to overcome. During the black-out a number of small shaded lamps afford the only illumination permissible. When an Alert is sounded—and contracts in vulnerable areas have a direct telephone line with the nearest police post and their own siren to give warning—all lights are automatically put out. But the job continues as slowly as is consistent with good concreting with the aid of hand torches.

Problems in Which the Army is Interested*

THE National Inventors' Council has secured the consent of the Army to the release of a list of some of the problems in which the Army is interested. A practical and effective solution of any of them will be a real contribution to the war effort. Actual war experience has shown the need for various devices or methods not practically available, and has also shown the need or the desirability of substitutes or alternatives for devices and methods already in our possession.

While information of the needs of the Army has only been given to agencies officially authorised to receive and use it, such a list has not heretofore been released since it might give information of what we possess or do not possess. The present list is not of this character and is being released to appropriate professional societies and research organisations in order that it may be passed along to their membership. Additional lists may be released in the future.

Suggestions on any of these problems should be submitted to the National Inventors' Council, Room 1313, Commerce Building, Washington, D.C., and should comprise a clear description of the proposal with such sketches or drawings as may be necessary.

(1) A method of removing the tetraethyl lead from leaded gasoline to make it useable in stoves, in lanterns, and in small engines.

(2) An inexpensive metal suitable for quartermaster tableware; one having requisite strength, freedom from corrosion by food acids or alkalies, durability, and attractiveness.

(3) Suitable substitute for rubber for insulating wire; should be flexible and durable.

(4) Detectors of enemy personnel who may be approaching (unseen) on jungle trails or fences or similar barriers.

(5) Sonic or supersonic means or methods of signalling in the field.

* Reprinted from *Mechanical Engineering*, the Journal of the American Society of Mechanical Engineers, September, 1943.

(6) Improved means or methods of signalling the identification of ground troops to friendly aeroplanes and *vice versâ*.

(7) Improved traction devices for wheeled vehicles of all types. NOTE.—Present chains and other devices are cumbersome, inconvenient to apply and remove, and lack sufficient traction.

(8) Tracks for tractors and other motorised equipment which will operate efficiently in snow and extreme cold.

(9) Better air cleaners for use on tank engines and the like; more effective than present cleaners and requiring less maintenance.

(10) Methods of quick-action waterproofing for enabling vehicles to ford water several feet deep without stalling engines.

(11) A storage battery not adversely affected by very low temperatures.

(12) The detector and method of locating non-metallic land mines.

(13) Equipment or methods for removing land mines rapidly from minefields without injury to equipment or personnel.

(14) Methods of rustproofing ferrous metals which are more durable than present methods, such as bonderising, &c.

(15) Absorbents for carbon monoxide or catalysts or other means for oxidation of this gas to render it non-injurious to personnel.

(16) Means of defeating darkness to permit vision at night without aid of visible reflected light. NOTE.—Probably involves an apparatus to translate infra-red rays to visible light.

(17) Means of long-distance communication outside the present scope of radio and not restricted by line-of-sight projection.

(18) Searchlights which may afford ready means for spreading the beam from narrow high intensity to 15 deg. of greatest intensity practicable.

(19) A simple non-toxic process for darkening aluminium and other metals, to make them non-reflectent to light.

(20) Methods of sabotage by friendly inhabitants within occupied areas.

Floating Airports*

SINCE the first direct crossing of the Atlantic Ocean by airplane, made more than twenty years ago by Alcock and Brown, flying across the North Atlantic has been made commonplace by the "Clippers" of Pan-American Airways and American Export Airlines, the huge flying boats of the British Imperial Airways, and the cargo planes of the Air Transport Command. Bombers and even single-seater fighters are now being regularly ferried across the ocean, the fighters with the aid of droppable gasolene tanks to supply sufficient fuel for the crossing.

Most of this flying involves long jumps, sometimes of the order of 2000 miles, and for very fast *de luxe* passenger service of the future it will not be surprising to see non-stop operation between New York and London or Paris.

For less expensive passenger service, however, and for carrying air cargo or express, such long hops involve difficulties. A tremendous amount of fuel has to be carried, because, in addition to the actual flight length, allowance has to be made for head winds, for possible loss of direction, for instrument approach, and for flying to an alternate airport. With high fuel loads, the actual payload (that is, passengers and cargo) is reduced to a small fraction of the gross weight of the airplane.

It is to meet this fundamental drawback of the airplane that there has once more come to light the idea of man-made islands to be moored in the North Atlantic for use as plane refuelling stations. Invented by Edward R. Armstrong as far back as 1915, and lately developed and sponsored by such important corporations as the Sun Shipbuilding and Dry Dock Company, United States Steel Corporation, Worth Steel Company, Lukens Steel Company, Belmont Iron Works, General Electric Company, and John A. Roebling Sons Company, the Armstrong seadrome has been patiently developed, step by step, and has now reached a point where far-sighted and hard-headed C. Bedell Monro, president of Pennsylvania-Central Airlines, has filed an application with the Civil Aeronautics Board for permission to connect eastern cities of the United States with seadromes in the North Atlantic and thence with ports of air commerce to be designated by the Civil Aeronautics Board.

The islands of steel, known as seadromes, consist of a floating platform 70ft. above the ocean, with buoyant elements so far down as to give a draught of 160ft. to 180ft. No matter how rough the ocean may be, these elements make the seadrome as steady as the mainland itself. Experiments made in a test basin with artificially created waves have given ample proof of the accuracy of this statement. To those who immediately visualise a huge steamship being tossed about in waves, the idea at first appears fantastic. Yet it is based upon sound principles of physics and extensive study of wave motion.

The ocean is destructive only when it is opposed, as near the coast. In mid-Atlantic vast rollers become harmless, particularly when allowed to travel through an open truss work as in the seadrome structure. But to explain why the seadrome remains level, despite ocean roughness, we must go to other facts of natural philosophy. The trochoidal wave of the surface of the sea has its companion form below, but the height of the wave formation decreases rapidly below the surface. At 30ft. below, the wave motion is scarcely perceptible. Therefore the buoyancy elements and the ballast elements of the seadrome are placed well below the surface. The diagram shows a 1500ft. seadrome in waves 600ft. in length and 30ft. in height. As the waves pass, the buoyancy varies slightly from flotation element to flotation element, but the sum of the buoyancies remains constant. Since the total buoyancy is constant, the seadrome neither rises nor falls with the waves.

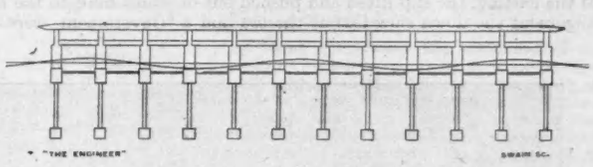

DIAGRAM OF SEADROME

Because of this constancy of buoyancy, because the wave motion almost disappears at depth, and because the power of the ocean is not challenged, the design of the seadrome is reduced to a problem in civil engineering not dissimilar to that of bridge construction. The design of the seadrome now under construction has been approved with a A-1 rating by the American Bureau of Shipping.

The floating airport will have a total displacement of over 100,000 tons and its landing deck will be 70ft. above sea level. The structure will be 3550ft. in length, 400ft. wide at the centre, and 280ft. wide at the ends—ample dimensions for taking care of large transports and capable of handling with ease an airplane of some 100,000 lb. gross weight, or possibly more. Auxiliary power sources and six electrically actuated propulsion units will deliver a thrust of 300,000 lb., sufficient to maintain the seadrome on station, even if the anchorage gear should fail.

The deck will be supported by seventy-two buoyancy tanks connected to it by means of streamlined steel and iron columns. The whole will form a deep truss composed of tubular struts and steel cable ties encased in iron pipes. Iron will be used because research has shown that iron, while not as strong as steel, provides greater protection against corrosion. The tanks will be arranged symmetrically in three rows of twenty-four each, with longitudinal spacing of 150ft. The lower columns extend to about 110ft. below the buoyancy tanks to support the ballast tanks. These contain sufficient ballast to lower the centre of gravity of the structure to about 8ft. below the centre of bouyancy, another reason for the extreme stability of the structure.

All exposed parts of the seadrome in the region of the waterline and above it will be of streamlined shape to reduce head resistance to a minimum. The lower columns will be circular in cross section, so that they may be unidirectional in water currents.

The deep-sea draught of the seadrome on station duty will be 165ft. Obviously, such great draught precludes erection close to the shore. Therefore, in order to make construction possible in shallow water, the ballast tanks are designed to telescope into the streamlined upper columns during erection. Decks and bulkheads will divide the tanks into twelve water-tight compartments. There will be bilge pumps and air pumps, as in a steamship.

The seadrome will be able to develop some forward speed, as previously stated, and its six screws will head it into the wind, as required for airplane operation, making a 90 deg. turn in from ten to fifteen minutes. With this built-in means of propulsion, the problem of towing the seadrome into position should be a relatively simple one. But to those who know how difficult it is to anchor even a lightship of 1000 tons in relatively shallow water, and how frequently lightships tear from their moorings, it may at first appear impossible to anchor a structure of 100,000 tons in the deep waters of the Atlantic, for if a ship of this size were to be moored in mid-ocean, wind and wave would indeed make the task impossible. But the seadrome will not pitch, roll, or heave at its anchor, and because of its constant buoyancy, the openwork structure will offer the least resistance to the motion of the water, while the upper above-water structure is streamlined. As a result, the natural forces acting on the seadrome are reduced to a minimum.

It is, however, necessary to guard against air forces reaching a velocity as high as 70 miles an hour. From seadrome tests made in the New York University wind tunnel and carried out by the writer of this article, a total anchorage pull of only 600,000 lb. is anticipated. With a factor of safety of 3½ included in the stress total, this would require the unheard-of wind speed of 140 miles an hour to break a seadrome loose from its anchorage.

Yet even 600,000 lb. is no small pull. The seadrome is to be anchored in mid-Atlantic where the depth of the ocean may be from 2 to 3 miles. It becomes impossible to use link chain, such as is ordinarily used with ships. The very best forged alloy steel chains would break from their own weight before they reached the bottom of the ocean at approximately 13,000ft. Suspension bridge cables, on the other hand, have ample strength to reach a depth of 60,000 ft., which is very considerably beyond the distance to the bottom of the deepest ocean. But cable must not be allowed to rub on the ocean bottom. For this reason, the anchorage cables will be slightly shorter than required for a given mooring and then will be extended at their lower ends by forged alloy steel chains, which, in turn, will be attached to the anchor. The anchor chains then will take up the wear and tear on the bottom. They should be able to withstand this for some twenty to thirty years.

The seadrome anchors, which function by friction, must weigh more than 1000 tons each. They will be equipped with flotation chambers, and so designed as to be built on a shipway, launched when completed, and then towed to position and sunk.

The facilities and equipment of the seadrome, though placed in unconventional surroundings, are to be quite conventional in character. There will be a luxurious hotel, located at the side of the main platform so as not to interfere with the operation of aircraft. There will be ample arrangements for refuelling and servicing of aircraft. A complete radio station and an equally complete weather bureau will be located on the structure. In general, the seadrome will be a combination of an airport

* From *Scientific American*, September, 1943.

terminal and a luxurious summer sea hôtel. It should be fascinating to spend a brief vacation in mid-Atlantic.

It is of interest to study the sketch map of the North Atlantic. The seadromes will be moored 800 nautical miles apart, and will be out of the region of fog and ice. Compare this distance with that between Botwood in Newfoundland and Foynes in Ireland, which is 1732 nautical miles, and that between Bermuda and the Azores, which is 1795 miles. To fly the seadrome route from Washington to Cherbourg means only 3200 miles in four hops of 800 miles each. Alternatively, Charleston to Bermuda is 765 miles, Bermuda to the Azores 1795 miles, the Azores to Lisbon 915 miles, and Lisbon to Cherbourg 798 miles, giving a grand total of 4273 nautical miles.

The cost of constructing a seadrome and getting it on station is expected to be around 12,500,000 dollars. Operating costs for three seadromes would be approximately 500,000 dollars annually, and maintenance costs should not be high.

Removal of Slip in Cutting on L.N.E.R. Main Line

Because of excessive water content on and under the cutting face, a slip occurred in the slope of a cutting on the down side of an L.N.E.R. main line in the London area. Besides threatening the stability of property at the top of the cutting, the slip lifted and pushed out of alignment the down slow line at the toe and a

Counterforts at Site of Slip in Cutting

speed restriction of 15 m.p.h. had to be imposed on trains using the track. Towards the end of 1941 a contract was placed with W. and C. French, of Buckhurst Hill, Essex, for the construction of counterforts and for the carrying out of drainage work. The work was commenced in October, 1941, and was completed in June of this year.

Twelve counterforts, 8ft. wide and having a maximum depth of 22ft., were constructed, as illustrated herewith. The excavation of these counterforts was carried down below the level of the slip, the bottom being stepped up to follow the line of cleavage. The counterforts were filled with rubble and the excavated material was tipped in the space between, the whole being brought up to a uniform slope of 3½ to 1. Finally 6in. of ashes were spread over the area between the counterforts. Each counterfort was drained into a permanent way drain between the down main lines. As the line of cleavage at the toe of the slip was below this drain, it was necessary to fill in the bottom step of each counterfort with concrete to bring it up to the required level. On Sunday, May 16th, 1943, possession of the down slow line was taken, the track removed, and the clay excavated to a depth of 2ft. below the underside of the sleepers. A dragline excavator was used for the purpose, and the clay was loaded into wagons standing on the down main line. A foot of sand was spread over the formation, and on top of this 9in. of ashes, the track finally being laid in on slag ballast.

Shipyard Labour in America

An interesting statement on the type of labour which is being employed in Pacific Coast American shipyards was given by Mr. Earl Riley, the Mayor of Portland, Oregon, who is at present visiting this country, on Monday, October 4th. He said that a great many of the men who were now employed in the great shipbuilding establishments which have been set up in Portland, Oregon, were farm hands before the war, but they rapidly adapted themselves to the craft of welding and the building of ships. He paid a high tribute to the men and the employers. Mr. Riley said that labour disputes had not been responsible for the loss of one hour of time in the defence industries of Portland. All interests, whether capital, industry, management, labour, and the civilian population, were working closely together in one accord. Before the outbreak of the present war Portland had not produced a single ship since the last war, when some ninety-nine were built. In the present war a record had been achieved, for no less than 54 per cent. of the ships built to the account of the United States Government were constructed on the Pacific Coast, and 30 per cent. of these were built in Portland shipyards. That success was directly due, Mr. Riley thought, to the climate, good working conditions, and the people's aptitude for shipbuilding. There was, he thought, less confusion, more co-operation, and less absenteeism than was possible in any other shipbuilding centre. In conclusion, Mr. Riley said that, while the American people were certainly not constantly subject to enemy attack, as were people in this country, they were endeavouring in every manner to emulate as far as possible the life of the Britisher on this island, who had to be constantly on the alert for enemy action. As far as living conditions were concerned, the conditions in America were not unlike our own.

Books of Reference

Oil and Petroleum Year Book, 1943. London: Walter E. Skinner, 20, Copthall Avenue, E.C.2. Price 12s. 6d. net.—The thirty-fourth edition of this work of reference gives complete particulars of more than five hundred companies, covering all branches of the oil industry. Changes that have taken place in the industry since the last edition of the book appeared are recorded. The "Buyer's Guide" to makers of oilfield and refinery equipment is another section which will be found useful to managers and engineers of oil and associated undertakings.

Universal Directory of Railway Officials and Railway Year Book, 1943–44. London: Directory Publishing Company, Ltd., 33, Tothill Street, S.W.1. Price £1.—Railway engineers and officers always find it helpful to keep in touch with railway personnel in other parts of the world for the purpose of exchanging information on research and development in the many phases of railway operation and maintenance. The "Universal Directory" is of great assistance to that end, and in spite of the limitations caused by war conditions, the forty-ninth edition contains complete lists of railway officials and concise descriptions of the chief railway systems of the world. The statistical and general railway information has, as usual, been carefully revised.

British Standards Institution

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1. The price of each specification is 2s. 3d. post free, unless otherwise stated.

VALVES AND GAUGES FOR AIR RECEIVERS

No. 1123—1943. This specification deals with fittings for air receivers and compressed air installations for maximum permissible working pressures not exceeding 1000 lb. per square inch, but does not deal with valves for portable gas cylinders. A section dealing with installation requirements is included, which requires that each receiver shall be protected by a suitable safety valve and a pressure gauge. A section is incorporated covering testing and inspection.

ECONOMY OF SOFT SOLDERS

Appendix A to B.S./STA. 7. This appendix deals with specifications for solders, particularly from the aspect of economy in the tin content. The recommendations have been prepared by an Advisory Panel of the British Non-Ferrous Metals Research Association under the chairmanship of Dr. H. Moore. The solders are classified in four series, viz.:—Lead-silver alloys, lead-tin-antimony alloys, lead-tin and lead-tin-antimony alloys with small additions of silver, and lead-tin and lead-tin-antimony alloys. Guidance as to the choice of an appropriate solder and suggestions for the uses for which the various solders are appropriate are given. Price 6d.

WATER-TUBE BOILERS AND INTEGRAL SUPERHEATERS

B.S. 1113—1943. The range of published British Standards for Boilers has been completed by the issue of a specification for Water-Tube Boilers and their Integral Superheaters. Details of materials specifications are given, covering plates and rivet bars, seamless forged drums, forgings other than seamless drums, tubes and headers, pipes, and steel castings. Complete formulæ are included governing the scantlings of the boiler, and these formulæ apply to boilers working under average normal conditions of draught, good feed water, and adequate supervision. Where working conditions are adverse, *e.g.*, abnormal evaporation, bad feed water, exposure to the elements, or where of necessity maintenance supervision will be inadequate, it is recommended that the scantlings found by calculation from the formulæ given should be increased. It is recognised that the design of water-tube boilers is the subject of continuous development, and it is intended to review this specification annually with a view to the incorporation of such modifications as are found desirable as a result of progress. Price 7s. 6d. post free.

China Building Ships.—The Chinese Government has taken delivery of ten ships designed and built by the Ming Sung Industrial Company for service in the shallow rivers of Szechwan Province. This fleet has cost 30 million dollars (Chinese national currency). Most of the vessels are passenger and cargo ships with maximum carrying capacity of 250 passengers. Each ship is driven by two engines of 36 H.P., has a draught of 5·6ft., and an average speed of 11·5 knots. Only small quantities of steel were imported for boiler construction. The hulls are of Szechwan timber, and are fitted with engines and boilers made in China.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer.

Report of the Combined Copper Committee

The latest report of the Combined Copper Committee in Washington shows that the new supply of copper is now roughly equal to its present actual consumption by the United Nations. The report was made to a full joint meeting of the Combined Raw Materials Board and the Combined Production and Resources Board. The Combined Copper Committee, like a number of other Committees of the two Combined Boards, is made up of representatives of the appropriate agencies of the Government of the United States (including the Army and Navy), the United Kingdom, and Canada. The Committee studies all phases of copper production, delivery, and use by the three countries and by others of the United Nations. The gap between future supply and demand as forecast by the Committee two months ago has been materially lessened and emphasis has shifted to man power in American brass mills. Stocks of copper have accumulated at brass mills owing to the fact that mills have been operating at less than capacity due to lack of adequate man power. There is, for instance, a shortage of man power in brass mills in the Connecticut Valley. Assurances have been received from Mr. Donald Nelson, Chairman of the War Production Board, that action is being taken in conjunction with the War Manpower Commission to remedy the situation in the brass mills by measures similar to those now being put into effect on the West Coast. The report states that the more favourable stock position is due to a number of factors. Demand as forecast some months back necessarily took into account the possibility of heavy sinkings of ships carrying ore and copper products. The position in this respect has recently much improved. The collection of copper scrap in the United States may also exceed previous expectations. Shipments from Africa to the United Kingdom have been speeded up. On the consumption side the stated requirements for certain kinds of ammunition have been substantially reduced and the use of steel for shell cases is increasing. All these factors have helped to bring supply and demand into balance. The Committee emphasised, however, that this balanced position is dependent on maintaining existing and projected production rates of new copper, collection of scrap, and the acceptance of steel cartridge cases. A phase of the problem of copper supply which is increasing in importance concerns the collection, shipment, and refabrication of battle scrap (see also "Iron and Steel Scrap" paragraph). The principal source of copper in battle scrap is found in spent artillery cartridge cases. Many of these need to be re-formed to be ready again for filling. Those which are too distorted in shape to be re-formed and all small-calibre cases must be re-melted. The metal then re-enters production channels in the form of ingots. The utilisation of battle scrap presents technical problems somewhat new to American refiners, due to contamination of spent cases by the explosive charge. Because of the interchange of production techniques, through the Combined Production and Resources Board channels, the U.S.A. will have the benefit of technical information on re-forming and re-melting methods used in the United Kingdom, where both this war and the last have provided experience in this field.

The Pig Iron Market

The appearance of the pig iron market has not greatly changed over the past few weeks. The most notable development is a gradual easing in the hematite pig iron position, and that of low and medium-phosphoric pig iron. This is due to an increased output resulting in larger supplies of high-grade iron ore from North Africa. It may be expected that this improvement will continue and that if more shipping becomes available much easier conditions will prevail in these departments. The demand for hematite is in excess of the production, and the Iron and Steel Control have to exercise care in releasing parcels. Engineering foundries are big users of hematite and have to use substitutes wherever this is possible. In consequence there is a run on refined and low-phosphoric pig iron and stringent conditions have prevailed in these departments for a long time. It seems unlikely that there will be any important increase in the allocations of hematite in the immediate future. Medium and low-phosphoric pig iron is required in large quantities by the engineering industry, particularly by those firms employed on castings for armaments, munitions, and tank construction. Liberal supplies of high-phosphoric pig iron are available and this description of pig iron is also used, but to a more limited degree than the low-phosphoric qualities. It is, however, used for purposes for which previous to the war it would not have been considered suitable. The normal demand for high-phosphoric pig iron from the light castings industry, which in peacetime was the largest consumer of this class of pig iron, has not been in evidence since the war began, and the principal products produced by the light castings foundries ceased to be manufactured in any quantity. A certain amount of work on small castings for the engineering industry is being undertaken by the light castings makers, but this is not nearly sufficient to compensate for the small quantity of the products normally manufactured. It seems unlikely that this branch of the industry will be fully employed for the duration of the war, since it is only to a limited extent that their plant can be used. There is a strong request for basic pig iron from the steel makers, and this is being met satisfactorily. There seems no likelihood of any tightness developing in this department, but a large production will be required to meet the enormous steel production.

Scotland and the North

There has been no noticeable change in the Scottish iron and steel industry. The works are fully occupied in their efforts to cope with the increasing war demand and have been successful in maintaining deliveries. As a result the tonnage of uncompleted orders at the end of the third period is comparatively small. Fresh allocations, however, have filled the capacity of most works until the end of the year. If any change in the incidence of the demand is likely, it would seem to be in the direction of an increase in the pressure for alloy steel, as it is generally expected that the big programme of aeroplane manufacture upon which the country is entering will result in a considerable expansion in the requirements of this steel. There has been no release in the consumers' demands upon the plate mills and large quantities are passing to the shipyards, wagon builders, and locomotive builders. The light structural steel position has become somewhat tight. The demand for heavy joists and sections is comparatively light and reasonable delivery of this material can be obtained, but the call for the lighter sections appears to be increasing and large tonnages are being produced by the re-rollers. This branch of the iron and steel industry is satisfactorily placed so far as supplies of semis are concerned, and recently there has been some falling-off in the call for crop ends, defectives, &c., although fair quantities are still being used. On the whole, the re-rolling industry is fully booked for some months ahead, but for the time being some firms appear to be disposing of orders more quickly than new business is coming forward. The demand for shell steel bars has declined somewhat as a result of changes in the production of munitions, but this may be only a temporary phase. Steel bars of all diameters are in strong request and large quantities of the larger diameter bars are passing to the engineering industry. The Lancashire iron and steel market is exceedingly active, but the general position does not show much change from that which has been ruling for the past few weeks. Although the call for alloy steel from the aircraft and armament makers has stood at a high level for a long time, there are indications that it will increase shortly. The pressure to obtain plates has been maintained and there is an important business passing in structural steel. The call for semi-finished steel is as strong as at any time this year and the re-rollers are taking large supplies. The forge masters also are important consumers. Great activity rules at the steel works on the North-West Coast and good tonnages of finished material, a large proportion of which comes within the priority category, are being produced by the works.

North-East Coast and Yorkshire

The carry over of orders by the North-East Coast steel works from delivery Period III to Period IV was not heavy, but the amount of new business placed has left the makers with sufficient work in hand to keep the industry busy for the last quarter of the year. There has been little change in the incidence of the demand, and where there has been any slackening in the request for certain descriptions it has been more than made up by an increased demand for other kinds of steel. It is evident that production will have to be maintained at a high rate to meet the requirements of the war industries. The output of semi-finished steel is on a high scale and the re-rollers are obtaining the supplies of billets they require, whilst the sheet works are receiving substantial tonnages of sheet bars. The re-rollers are heavily employed on the production of small structural shapes, small bars and strip, and, in addition to their supplies of billets and sheet bars, are using quantities o defectives, crops, and, indeed, any re-rollable material. Withdrawals of American materials from the stocks which have been accumulated in this country are on a much reduced scale, but it has been found necessary to release a certain amount. The insistent call for plates shows little change and the mills are fully engaged and likely to remain so for an indefinite period. To help the strain upon the plate mills the sheet works have been called in to produce considerable quantities of thin plates. The greater proportion of the output of plates is going to the shipyards, but considerable quantities are required by locomotive builders and wagon builders and the demand from this quarter has increased of late, as fresh Government orders have been placed. Although the general rate of production in the Yorkshire steel industry has been on a heavy scale in one or two departments, there has been a lull. This, however, is only a temporary phase and the demand for practically all descriptions of finished steel is heavy. The production of basic steel is being pressed to the utmost, and lately there appears to have been an increase in the production of structural steel and some of the works have reduced their delivery dates. The production of acid carbon steel has been heavy for some time and all the available plant is fully occupied. The production of alloy steel is also pressed to the utmost and the engineering industry is taking up considerable quantities. The more expensive descriptions of alloy steel, however, are not in such urgent demand. The call for tool steel is moderate, but there are indications that the demand will revive shortly.

Iron and Steel Scrap

Some irregularity has developed in the scrap market of late, and whilst in some districts there has been a revival of activity in practically all departments of the scrap steel industry, in others the conditions which have prevailed for some time show no change. The demand is concentrated upon the heavier and better classes of steel scrap and the lighter are attracting comparatively little interest. The insistent demand for heavy mild steel scrap cut to furnace and foundry sizes has not relaxed and consumers pick up all the parcels offering. The acid steel makers, also, are taking good quantities of bundled steel scrap and hydraulically compressed steel shearings. Some improvement has been noticeable lately in the demand for mild steel turnings, and both good heavy and chip grades are passing into consumption on a fairly active scale. The request for mixed wrought iron and steel scrap for basic steel has improved and there is some shortage of supplies of the good heavy quality. The stringency in this department has resulted in the development of a stronger demand. A quiet business is passing in light material, but there are indications that consumers are taking more interest in this quality and larger quantities have recently passed into consumption. A rather better demand has developed for compressed basic bundles and consumers seem anxious to obtain larger quantities of heavy material, which is in rather short supply. Heavy cast iron in large pieces and furnace sizes is in strong request and machinery cast scrap in cupola sizes is rapidly taken up by consumers. A development of interest to this country has recently occurred in the United States, and it is reported that thousands of tons of battlefield scrap have been unloaded in one of the American ports. The material suitable for repair is sold through normal trade channels for return to the war effort. The quantities of this battlefield scrap are increasing to such a degree that the American Army has established a segregation yard at a port of embarkation in North Africa. The scrap is sent to this yard for distribution under the guidance of officers who have had experience in the scrap and salvage industry. During May ships landed in one part of the United States 1500 gross tons of ferrous scrap and 400,000 lb. of non-ferrous scrap. In June the quantities reached 2700 tons of ferrous scrap and 763 tons of non-ferrous scrap. According to the American Press, the volume of scrap which has been received in the United States is increasing.

"POLECTRON."—This is the name that has been given to an American synthetic substitute for mica. Polectron has a melting point of about 300 deg. Fah., and an insulating capacity comparable to mica. It can be used in the same production lines as sheet mica, and will not require changes in industrial methods. Its brittleness, shared with natural mica, has been overcome by a special technique. The material is easier to work than natural mica, and it is estimated that 1 lb. of Polectron will replace 10 lb. or 15 lb. of natural mica.

Notes and Memoranda

Air and Water

RUBBER BOATS.—Boats made entirely of rubber and planned for use in transporting raw materials from the South Pacific to Japan are now under construction. The boats are towed by ordinary power-driven vessels. On arrival at their destinations they will be converted into rubber products.

FIRST CANADIAN-BUILT "LANCASTER."—The first Canadian-built "Lancaster" bomber has recently arrived in this country, and has been christened the "Ruhr Express." This machine flew the Atlantic from Newfoundland in 9½ hours, landing at a British airport half an hour before the estimated time of arrival with 300 to 400 gallons of petrol still in its tanks.

NORTH SCOTLAND HYDRO-ELECTRIC BOARD.—The Secretary for Scotland recently announced that the following have been appointed members of the North of Scotland Hydro-Electric Board:—The Earl of Airlie (Chairman), Mr. A. E. MacColl, Mr. Neil Beaton, and Mr. Hugh Mackenzie. The Central Electricity Board has appointed Mr. Walter K. Whigham to be its representative on the Board.

CANADA'S NEXT AIRPORT.—Edmonton, on the main air route to Alaska and to Siberia, is to have a new airport, and the contract for its construction has been awarded to a company in Vancouver. The contract amounts to approximately 6½ million dollars. Of this, 4½ million will be spent on a new airport at Namao, just outside Edmonton, and 2 million on improvements and extensions to the present airport in Edmonton.

THE PEACE RIVER BRIDGE.—Rapid progress is being made on the final construction stages of the 2000ft. suspension bridge across the Peace River near Fort St. John. The last sections of the steel have been laid, and a start has been made on laying the two-way, 24ft., concrete traffic deck. Good progress also is reported from Canada on the 900ft. suspension bridge across the Laird River and also the structure over the Muskwa River. All three projects will play an important part in expediting traffic over the Alaska Highway.

PAPER PETROL TANKS FOR AIRCRAFT.—Auxiliary petrol tanks made from paper are now being used by our "Typhoons" and other fighter aircraft. Known as "jettison tanks," because being carried under the fuselage they can be discarded by the aircraft when necessary, these containers carry the extra fuel required by our fighters for long-range activity. After careful experiments, it has been found that paper, processed in a certain way, can be made sufficiently tough for this purpose. The tanks, which are cigar shaped, are made in three sections. Each section consists of layers of paper, bonded together with an adhesive, and moulded to the required shape. After they have been dried and sand-papered, the three sections are assembled and a band of wood inserted at the joints. Small metal fitments are then added, after which the tank is "doped" and finally sprayed with silver cellulose paint.

Miscellanea

PARSONS MEMORIAL LECTURE.—The eighth Parsons Memorial Lecture will be delivered by Lord Rayleigh at the Royal Institution, Albemarle Street, W.1, on Friday, October 15th, at 4.30 p.m. The subject of the lecture is "Optical Topics, in Part Connected with Charles Parsons."

MAINTENANCE OF PLANT IN CLOSED FACTORIES.—The Ministry of Fuel and Power has stated that the attention of its Fuel Efficiency Committee had been drawn to the fact that there are a number of cases—few in proportion, but substantial in total—of wasting fuel in factories which had been closed in concentration schemes, and where heating is still maintained in order to keep the disused production machinery in suitable condition. It is recognised that plant maintenance requirements vary widely, not only between industry and industry, but between one type of plant and another, but there is evidence that there are frequent cases where precautions can be taken to protect plant without the need for specially heating the building. Representative bodies of industries which had been concentrated had been asked to survey the conditions in closed factories in order to ensure that, wherever possible, the heating of buildings for plant maintenance purposes is eliminated in favour of other protective methods, such as spraying metal parts with anti-rust preparations and turning over periodically, or applying heavy grease and covering with sheets. The fuel supply position is such that the utmost economy must be exercised, and it is with this in mind that managements of closed or partly closed factories are urged to survey the position to ensure that every possible means of saving fuel is adopted before the colder weather begins.

NO NICKEL SHORTAGE.—Thanks to the energy with which last year's programme was pursued by the International Nickel Company of Canada, the promised production rate of 50 million pounds over the 1940 rate was attained last year. Work on production expansion has progressed according to schedule and is largely completed. All of the works ran continuously throughout the year.

IRON AND STEEL INSTITUTE.—The autumn general meeting of the Iron and Steel Institute will be held at 4, Grosvenor Gardens, London, S.W.1, on Thursday, October 14th, at 11 a.m. and 2.45 p.m. At the morning session the following papers will be presented:—"A Study of Austenitic Grain Growth in Medium-Carbon Steels," by J. H. Whiteley; "The Structure and Segregation of Two Ingots of Ingot Iron, One Containing Lead," by L. Northcott and D. McLean; and "Leaded Manganese-Molybdenum Steel," by T. Swinden. In the afternoon the following papers will be read:—"The Solidification and Cooling of Steel Ingots: Notes on an Examination of Three Typical Ingots," by E. F. Law and V. Harbord; and "The Physical Chemistry of Open-Hearth Slags," by J. White.

Personal and Business

MR. W. W. WOOD has been re-elected Master Cutler of Sheffield.

MR. A. M. CAMPBELL has been elected a director of the Union-Castle Mail Steamship Company, Ltd.

MR. W. R. T. SKINNER has been appointed general manager of the Yorkshire Electric Power Company.

THE MINISTER OF WAR TRANSPORT has appointed Sir George Campbell to be Regional Port Director for South-East England, including the Port of London.

THE INSTITUTION OF MINING ENGINEERS has secured offices at Salisbury House, Finsbury Circus, London, E.C.2. A reading room, containing current periodicals, will be available for the use of members at the new address. The joint library, however, will continue to be housed at Mill Close Mine, Darley Dale, Matlock, Derbyshire.

MR. G. R. SHARPLEY, chairman and managing director of Ruston and Hornsby, Ltd., Lincoln, is retiring from that position at the end of the year. He will continue to be the chairman of the company. Mr. Sharpley has been with the company for over fifty years and has occupied the office of managing director for practically twenty-five years. Mr. V. W. Bone, who is a member of the board of directors, will relinquish his position of managing director of Ruston-Bucyrus, Ltd., and will be Mr. Sharpley's successor as from January 1st, 1944. The board of Ruston-Bucyrus, Ltd., has appointed Mr. E. S. Everitt, at present the assistant managing director of Ruston-Bucyrus, Ltd., to succeed Mr. Bone as the managing director of that company.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Derby Society of Engineers

Monday, Oct. 11th.—School of Arts Lecture Theatre, Green Lane, Derby. "Generation of Electricity in Great Britain," W. Warren. 6.30 p.m.

Diesel Engine Users Association

Thursday, Oct. 14th.—Central Hall, Westminster, S.W.1. Discussion, "Heavy-Oil Engine Working Costs Report," opened by C. Green. 2.30 p.m.

Illuminating Engineering Society

Tuesday, Oct. 12th.—E.L.M.A. Lighting Service Bureau, 2, Savoy Hill, W.C.2. "The Design and Application of Fittings for Fluorescent Lamps," W. R. Stevens. 5 p.m.

Institute of Economic Engineering

Sunday, Oct. 10th.—Waldorf Hotel, Aldwych, W.C.2. "Estimators and Estimating," E. E. Bean. 2.30 p.m.

Institute of Fuel

Thursday, Oct. 14th.—Connaught Rooms, Great Queen Street, Kingsway, W.C.2. Presidential Address, by Dr. E. M. Smith. 12.30 for 1 p.m.

Monday, Oct. 18th.—N.E. SECTION: Central Station Hotel, Newcastle-upon-Tyne. "The Need for Industrial and Scientific Co-operation," J. G. Bennett. 5.30 p.m.

Institute of Marine Engineers

Tuesday, Oct. 12th.—85, Minories, E.C.3. "Ventilation of Ships' Machinery," J. K. W. MacVicar. 5.30 p.m.

Institute of Transport

Tuesday, Oct. 12th.—Institution of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2. Presidential Address, by Sir William Wood. 5 p.m.

Institute of Vitreous Enamellers

Saturday, Oct. 9th.—Waldorf Hotel, Aldwych, W.C.2. Annual general meeting. 11.30 a.m.

Institute of Welding

Wednesday, Oct. 13th.—Conway Hall, Red Lion Square, Holborn, W.C.1. "Some Aspects of Machine Design," E. Hassler. 5.30 p.m.

Institution of Chemical Engineers

Tuesday, Oct. 12th.—Inst. of Mechanical Engineers, Storey's Gate, Westminster, S.W.1. "The Future of the Chemical Industry," Lord McGowan. 2.30 p.m.

Institution of Civil Engineers

Saturday, Oct. 9th.—YORKSHIRE ASSOC.: Hotel Metropole, Leeds. Chairman's Address, by K. L. Forster. 2.30 p.m.

Institution of Electrical Engineers

Tuesday, Oct. 12th.—SCOTTISH CENTRE: Royal Technical College, George Street, Glasgow, C.1. Chairman's Address, by D. W. Low. 6.15 p.m.—N. MIDLAND CENTRE: Great Northern Hotel, Wellington Street, Leeds. Chairman's Address, by W. T. J. Atkins. 6 p.m.

Wednesday, Oct. 13th.—WIRELESS SECTION: Savoy Place, Victoria Embankment, W.C.2. Chairman's Address, by T. E. Goldup. 5.30 p.m.

Thursday, Oct. 14th.—INSTALLATIONS SECTION: Savoy Place, Victoria Embankment, W.C.2. Chairman's Address, by A. G. Ramsey. 5.30 p.m.

Friday, Oct. 15th.—S. MIDLANDS STUDENTS: Loughborough College, Loughborough. "Turbo-Alternator Ventilation," H. R. Ogle. 6.30 p.m.

Saturday, Oct. 16th.—S. MIDLAND CENTRE: Grand Hotel, Birmingham. Chairman's Address, by D. Kingsbury. 12.30 for 1 p.m.

Institution of Engineers and Shipbuilders in Scotland

Tuesday, Oct. 12th.—39, Elmbank Crescent, Glasgow. Presidential Address, by A. M. Stephen. 6.30 p.m.

Institution of Mechanical Engineers

Saturday, Oct. 9th.—YORKS GRADUATES' SECTION: Hotel Metropole, Leeds. "The Mining and Making of Ferodo," W. S. Blackie. 2.30 p.m.

Institution of Production Engineers

To-day, Oct. 8th.—EASTERN COUNTIES SECTION: Ipswich Museum, Ipswich. "Local Hardening," E. Bramhill. 7 p.m. MANCHESTER SECTION: Mechanics' Institute, Crewe. "Production Control," R. Appleby. 7.15 p.m.

Saturday, Oct. 9th.—MANCHESTER SECTION: Liverpool University, Brownlow Hill, Liverpool. "Production Control," R. Appleby. 2.30 p.m. YORKS SECTION: Hotel Metropole, Leeds. "The Production Technique of Industrial Plastic Mouldings," T. H. Richardson. 2.30 p.m.

Monday, Oct. 11th.—COVENTRY GRADUATES' SECTION: Technical College, Coventry. "Any Questions?" 6.45 p.m.

Institution of Professional Civil Servants

Tuesday, Oct. 19th.—Inst. of Mechanical Engineers, Storey's Gate, Westminster, S.W.1. "Radio and International Relations," Sir Stafford Cripps. 5 p.m.

Iron and Steel Institute

Thursday, Oct. 14th.—4, Grosvenor Gardens, S.W.1. Autumn general meeting. 11 a.m. and 2.45 p.m.

Junior Institution of Engineers

To-day, Oct. 8th.—39, Victoria Street, Westminster, S.W.1. "Economy of Fuel and Power," W. A. Christianson. 6.30 p.m.

Friday, Oct. 15th.—39, Victoria Street, Westminster, S.W.1. "Research for Junior Engineers," R. A. Collacott. 6.30 p.m.

The Newcomen Society

Wednesday, Oct. 13th.—Chartered Institute of Patent Agents, Staple Inn Buildings, Holborn, W.C.2. "Norris Locomotives in England and Europe," P. C. Dewhurst. 2.30 p.m.

North-East Coast Institution of Engineers and Shipbuilders

Friday, Oct. 15th.—Literary and Philosophical Society, Newcastle-upon-Tyne. Presidential Address, by J. Ramsay Geddie. 6 p.m.

Physical Society

Friday, Oct. 15th.—Royal Institution, Albemarle Street, W.1. Parsons Memorial Lecture, "Optical Topics, in Part Connected with Charles Parsons," Lord Rayleigh. 4.30 p.m.

Practical Planning Exhibition

To-day to Saturday, Oct. 30th.—Institution of Civil Engineers, Great George Street, S.W.1. 10 a.m. to 6 p.m. (except Sundays).

Royal Institute of Chemistry

Saturday, Oct. 9th.—S. YORKS SECTION: Department of Applied Science, St. George's Square, Sheffield, 1. Joint meeting. "Microchemical Analysis." 2.30 p.m.